DIGITAL COMPUTER NEWSLETTER

The purpose of this newsletter is to provide a medium for the interchange, among interested persons, of information concerning recent developments in various digital computer projects

OFFICE OF NAVAL RESEARCH • PHYSICAL SCIENCES DIVISION

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Editorial Policy Notices

EDITORIAL

The Digital Computer Newsletter, although a Department of the Navy publication, is not restricted to the publication of Navy-originated material. The Office of Naval Research welcomes contributions to the Newsletter from any source. The Newsletter is subjected to certain limitations in size which prevent publishing all the material received. However, items which are not printed are kept on file and are made available to interested personnel within the Government.

DCN is published quarterly (January, April, July, and October). Material for specific issues must be received by the editor at least three months in advance.

It is to be noted that the publication of information pertaining to commercial products does not, in any way, imply Navy approval of those products, nor does it mean that Navy vouches for the accuracy of the statements made by the various contributors. The information contained herein is to be considered only as being representative of the state-of-the-art and not as the sole product or technique available.

CONTRIBUTIONS

The Office of Naval Research welcomes contributions to the Newsletter from any source. Your contributions will provide assistance in improving the contents of the publication, thereby making it an even better medium for the exchange of information between government laboratories, academic institutions, and industry. It is hoped that the readers will participate to an even greater extent than in the past in transmitting technical material and suggestions to the editor for future issues. Material for specific issues must be received by the editor at least three months in advance. It is often impossible for the editor, because of limited time and personnel, to acknowledge individually all material received.

CIRCULATION

The Newsletter is distributed, without charge, to interested military and government agencies, to contractors for the Federal Government, and to contributors of material for publication.

For many years, in addition to the ONR initial distribution, the Newsletter was reprinted by the Association for Computing Machinery as a supplement to their Journal and, more recently, as a supplement to their Communications. The Association decided that their Communications could better serve its members by concentrating on ACM editorial material. Accordingly, effective with the combined January-April 1961 issue, the Newsletter became available only by direct distribution from the Office of Naval Research.

Requests to receive the Newsletter regularly should be submitted to the editor. Contractors of the Federal Government should reference applicable contracts in their requests.

All communications pertaining to the Newsletter should be addressed to:

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Computers and Data Processors, North America

RCA Spectra 70 Series
Radio Corporation of America
New York 20, New York

INTRODUCTION

The first of a new generation of electronic computers, designed to meet the total information processing requirements of science and industry well into the 1970's, was announced here today by Radio Corporation of America.

This new computer series, called Spectra 70, combines technological advances that not only match, but go beyond those of any other known computer system. First in the third generation of data processing systems, Spectra 70 presents major innovations in logic circuitry and language capability.

Comprised initially of 4 compatible general purpose computers and more than 40 interchangeable peripheral devices, the new RCA series features these principal innovations:

- In the two larger computers, the first use of fully integrated circuits—world's fastest and most reliable commercially available circuits of their kind;

- An advanced "multi-lingual" capability, enabling Spectra 70 computers to "speak" all of the most common programming, data, and communications languages, including those of the most recently announced computer systems; and

- Improved cost/performance ratios, over the full range of systems and applications.

Spectra 70 provides a complete spectrum of computing, peripheral, and communications equipment, and it meets the full range of system and application requirements of science and industry. Rental prices range from $800 a month for the smallest processor to $22,550 a month for the largest processor.

The ability of the Spectra 70 Series to accommodate the programs of other computers has broad implications for the company hoping to evolve to a total management information system. The new computers have been designed to live harmoniously with many of their contemporaries. Their fluency in other computer languages greatly lessens costly re-programming and makes possible greater management control for the computer dollar than ever before.

Advanced production of the Spectra 70 Series has already begun in the RCA Palm Beach Gardens computer plant, and customer deliveries will begin in the fourth quarter of 1965. The new series takes its place alongside RCA's well established 301, 3301, and 501 computers, and will be able to accommodate programs written for these as well as other non-RCA systems.

RCA's decision to pioneer as the first company to manufacture computers in quantity with fully integrated circuits was the result of logic circuitry research begun some years ago in RCA Laboratories. Success of this research and development of new manufacturing techniques for the circuitry provided RCA with the means of creating this third generation of computers.

The new Spectra 70 Series in initial form consists of four computers identified as the 70/15, 70/25, 70/45, and 70/55. The four provide all of the elements needed for total information systems, including an extensive array of data storage, communications, and input-output equipment.

The two larger computers in the series, the 70/45 and 70/55, employ high-speed integrated circuits with typical switching times of 7 nanoseconds (billionths of a second) or less. Each of the circuits is formed of a silicon chip so small that it would barely cover the letter "o" of a typewriter, yet large enough to contain two complete electronic circuits with 15 transistors and 13 resistors. This type of circuit is called "monolithic," because all of the electronic elements are combined in a single bit of material.

These specially developed integrated circuits represent a major step beyond the most

advanced type of circuitry previously announced—a hybrid form in which chip transistors and diodes are mounted separately on a printed circuit module approximately 1/2 inch square. In addition, their use in the Spectra 70 Series permitted a one-third reduction in the size of computer cabinets.

The new integrated circuits are described by RCA engineers as faster, more reliable, and more economical than any such circuit technique now in commercial use or so far announced. With the circuits, RCA computer specialists also have developed for the Spectra 70 Series a circuit-linking technique that effectively reduces problems of signal interference among adjacent circuits, and virtually eliminates all conventional wiring.

Design of the new series itself was aided by extensive automated design techniques, in which circuit and system layouts were produced by an electronic computer.

Among the most significant aspects of Spectra 70, according to the RCA specialists, is its compatibility with the programming languages, communications codes, and data formats of other computers. The "native tongue" of the Spectra 70 systems is the Extended Binary Coded Decimal Interchange Code (EBCDIC), and each of the new computers can generate and work with the American Standard Code for Information Interchange (ASCII).

As a result of this multi-lingual capability, the new RCA computers pace the industry in protecting the computer user's investment in past data processing systems and in offering him equipment designed to handle all his anticipated future data requirements.

The series has been designed for a full range of users, including banks, insurance companies, manufacturing concerns, transportation companies, utilities, research laboratories, and government agencies.

In application, the Spectra 70 computers will handle a wide range of information processing, from the analysis of exotic rocket fuels and the solution of highly complex scientific problems, to such data processing functions as statistical reporting, accounting, and market evaluation.

Spectra 70 is a completely homogeneous family of computers, with hardware and software fully integrated. The new RCA line makes extensive use of advanced, highly sophisticated software techniques.

LANGUAGE ABILITIES

RCA's Spectra 70 Series marks the third generation of computers as much through its advanced language ability and the unparalleled freedom this gives the computer user, as through its use of the latest electronic technology.

The ability of the Spectra 70 computers to talk all of the most common programming, data and communications languages cuts the high cost of re-programming and makes possible effective communication between computers, including computers of other manufacture.

The new RCA family of multi-lingual computers goes further in the direction of providing the flexibility needed to protect the computer user's investment in the past, while still meeting his needs of the present and for the future, than any other system. The exceptional language fluency of Spectra 70 computers is achieved at four levels, each of which add to the total pattern of flexibility that has been achieved.

One of the most significant advances is the Spectra 70 Meta-assembler . . . a new concept in assembly languages that give the user the ability to create his own problem-oriented language.

The British philosopher and mathematician, Bertrand Russell, pointed out that the problem of studying language is that the study is conducted in language itself. Thus he calls for a "meta-language"—a symbolic notation that would permit language study in another system of logic.

An almost identical problem, not philosophical, but very practical, has occurred in computers. The computer has a language of its own—a binary language of one's and zero's that can be understood and manipulated by man, but only with great difficulty and painstaking attention to minute details.

From the beginning of the computer era, man has been trying to get together with his machines to find languages that both can understand and use effectively. But there has been no truly common system of notation between man and machine, although there have been common languages for men that have been implemented on many machines. The many assemblers and compilers that have been developed to translate these languages to machine code are separate accomplishments for each language and for each machine. Thus, each

language developed for each machine has been a "one-shot" answer to the problem.

In effect, RCA's meta-assembler says that there are a finite number of manipulations and expressions for the computer. It seeks to describe them in a standard set of symbols and rules. This allows either the user or the manufacturer to describe the syntax or semantics of a new language and thus makes it practical to create new, specialized languages quickly, and economically.

Neither the average programmer nor the computer needs to know the meta-language—it is independent of both. Thus the user can describe his programs in a particular notation familiar to him, and the meta-assembler will provide a program in machine language (called an "object program," in computerese) that the computer understands.

At the programming level, the multi-lingual Spectra 70 series will "speak" FORTRAN IV and COBOL, other languages as they become finalized and accepted by the industry as standards, as well as Spectra 70 and other assembly languages.

This broad combination of programming languages, plus the Spectra 70 Meta-assembler system makes it easy and economical to accommodate a wide variety of higher-order languages. This allows the computer user to select the most efficient language for a given application and ease conversion problems.

At the machine language level, all Spectra 70 non-privileged instructions, formats and characters codes are identical with the corresponding features in IBM's System 360. This instruction language capability is further enhanced by stored logic in the read-only memory of the larger computers that make it possible to create new order codes. The machine codes that may be handled in this way include the RCA 301, 501, and 3301 and the IBM 1401 computers, as well as other popular machines.

At the data language level, the native tongue of Spectra 70 computers is Extended Binary Coded Decimal Interchange Code (EBCDIC). Other codes that can be talked to and worked with are the American Standard Code for Information Interchange (ASCII), the industry standard seven-bit plus parity code, and the seven- and five-level teletype codes. All fit within the basic eight-bit plus parity structure of the Spectra 70 Series.

Spectra 70 computers also communicate through a wide variety of document codes for effective handling of punch cards, punched paper tape, mark read cards, and documents printed for optical or magnetic character recognition.

COMMUNICATIONS CAPABILITIES

Making possible for the first time a gradual, economic evolution from routine data processing to total management systems, the Spectra 70 Series has been designed with an unprecedented range of communications capabilities.

Through communications equipment and techniques planned to fill a virtually unlimited variety of requirements, the data processor has become a powerful and far-reaching aid in decision making, management control and long range planning.

The computer-communications team extends the range and scope of the centrally-located computer, making available on a real-time basis facts and figures from local or remote locations. The computer has been linked directly to data sources within the same plant or across the continent.

The increasing tie-in of computers and communications facilities has made possible direct dealing with information from a wide variety of sources, regardless of location. To illustrate the growth of data communications, Bell system private long-line circuit use for data transmission has risen from 500 such circuits totalling 400,000 miles in 1960 to 5700 circuits covering over 2.5 million miles today—an increase of more than six-fold.

Spectra 70 computers achieve the widest possible use of data flow to and from telegraph, telephone, microwave, and such specialized communications systems as the Department of Defense AUTODIN (Automatic Digital Information Network) hookup. Five basic buffers cover this broad spectrum of data movement.

The Spectra 70 communications concept allows memory-to-memory traffic between Spectra 70 computers at the same site as well as memory-to-memory communications between remotely located Spectra 70 computers over voice grade communication facilities. It also provides for memory-to-memory communications over voice grade facilities between Spectra 70 computers and RCA 301 and 3301 systems.

In addition to this form of high speed single channel communications, Spectra 70, through an optional communications Multiplexor Channel, can be the heart of an advanced integrated

Computer-Communication System by dealing with up to 256 communication lines covering a range of speed up to 5100 characters per second.

Data communications systems have evolved over the years by gradual expansion with myriad devices and facilities, so that it is not uncommon today for a single company to have communications services and terminal equipment from various common carriers and equipment suppliers.

These devices and services have been justified economically in their own discrete areas and have served a useful function in hybrid management information systems; however, the drawbacks have been many. The addition of even one new standard remote communications terminal at any point results in personnel retraining expenses, together with added implementation costs.

Based on nearly a half century of communications experiences on a world-wide basis, RCA has pursued an open-minded, open-ended approach to the broad field of data communications. This has manifested itself in an RCA computer-controlled electronic switching system now in operation at the RCA Communications Company's New York headquarters, connecting with some 70 foreign countries.

In designing Spectra 70, RCA not only made provision to accommodate existing common carrier record communications facilities, but also took into account the newer data communications codes and formats in ASCII (American Standard Code for Information Interchange) oriented systems. FIELDATA codes and future ASCII first and second level codes also can be assimilated by Spectra 70. Further provision has been made to allow the computers to converse with remote communications terminals of varied manufacture over standard communications facilities.

SPECTRA 70 COMMUNICATIONS AND RANDOM ACCESS CAPABILITIES

For total information management systems today or a decade hence, the Spectra 70 processors have been designed to employ a comprehensive range of communications capabilities and random access memory devices with multi-billion character capacity.

The ability of Spectra 70 computers to communicate is in keeping with RCA's role as a communications innovator, involving such computer-controlled communications tasks as the Ballistic Missile Early Warning System, the Air Force Logistics Command System, the Electronic Telegraph System of RCA Communications, Inc., and supplier to Western Union of the world's largest electronic switching system.

Spectra 70 communications equipment and techniques permit:

- RCA computers to interchange information, memory to memory, at the same site or between widely separated locations.
- The on-line flow of data between the computer and such remotely located operations as warehouses, plants, and regional and branch offices.
- The gathering of data from in-plant operations through the direct connection of RCA EDGE electronic data gathering units to the central processor.
- Data flow into the computer to and from telegraph, telephone, microwave, and specialized communications systems including the Department of Defense AUTODIN (Automatic Digital Information Network) hookup.
- Swift reply to information requests on a local or remote basis by means of inquiry and display units connected directly to the electronic data processing system.
- Real-time acquisition of vital data for decision makers.

Data Exchange Control (DXC) (RCA Model 70/627)

The new DXC allows computers in the Spectra 70 Series to be linked memory-to-memory at the same site, as much as 200 feet apart. Data can be moved through the DXC in bursts of eight bytes at speeds up to 640,000 bytes per second, depending on the processor, the channels used, and the number of simultaneously active devices.

Single-Channel Communications Controls (CC) (Models 70/652-25-26 and Models 70/653-25-26-34)

The Spectra 70 Series provides five models of single channel communication controls to bring distant computers into memory-to-memory communications.

Single-Channel Communication Controls, installed in Spectra 70 processors, are connected through one of two types of subsets, to leased or dial network communications lines. Either manual or automatic dialing can be used to set transmission in motion.

Data speeds vary with the CC model from 220 bytes per second to as much as 5100 bytes per second.

Any Spectra 70 computer with CC may be linked to other Spectra 70 processors, RCA 301 or RCA 3301 computers similarly equipped.

Communications Multiplexor Channel (CMC) (Model 70/672)

The Spectra 70/45 processor can be equipped with an optional Communications Multiplexor Channel to handle as many as 256 on-line devices in the form of input/output units or terminals. A combined data rate of 10,000 bytes per second can be attained.

The CMC is designed to accommodate all existing communications services and probable future services.

Operation is automatic once the conditions for interrupt and sequencing of data flow has been established. Only the programming parameters have to be changed to handle new or additional remote terminals with different communications characteristics. The wired-in program is stored in a special "read only" memory.

Six types of line buffers make possible tie-in with a wide variety of communications facilities.

Mass Random Access Storage and Retrieval

Spectra 70 computers have at their disposal three random access storage and retrieval systems—Drum Memory unit, Disc Storage unit and Mass Storage unit. All three memories are operated by the RCA 70/541 Random Access Controller with up to eight devices at a time connected in any combination.

Drum Memory Unit (RCA 70/565)

The Drum Memory unit supplies fast direct access storage and is particularly useful as an extension of internal main core memory for greater economy. The drum capacity is one million bytes or two million decimal digits. The data transfer rate is 119,000 bytes or 238,000 decimal digits per second.

Disc Storage Unit (RCA 70/564)

Serving as an extension of internal main memory, the Disc Storage unit provides medium-capacity random access as the main storage for operating systems and working programs, or where fast direct access is of prime concern.

The average access time is 85 milliseconds with the track-to-track access 30 milliseconds and the rotation time 25 milliseconds.

The capacity is 7.25 million bytes or 14.5 million decimal digits per disc unit while up to eight units can be attached to a single Controller for an overall capacity of 58 million bytes or 116 million decimal digits. The data transfer rate is 156,000 bytes or 312,000 decimal digits per second.

Mass Storage Unit (RCA 70/568)

The 70/568 provides a mass data base online with low-cost random access and multi-billion-character capacity. The unit is designed to exploit the speed and "throughput" power of the Spectra 70 Series, pinpointing facts in a fraction of a second.

Data storage involves flexible magnetic cards 16 by 4-1/2 inches. Interchangeable magazines in each file house 256 cards. Each unit can handle from one to eight magazines. An optional expansion assembly increases the magazine capacity to 16.

PROCESSOR

The new RCA Spectra 70 series initially comprises four compatible electronic data processors, ranging in price from $800 monthly rental at the lowest end of the line to $22,550 for the largest memory at the upper end.

The processors feature memory cycle speeds of 2 microseconds for the Spectra 70/15, the smallest, to 840 nanoseconds for the largest, the Spectra 70/55. Memory sizes range from 4,096 bytes to 524,288 eight-bit bytes, respectively.

The new processors provide multi-lingual compatibility, real-time processing, and the

capability to utilize more than 40 kinds of peripheral devices. Standard interface units allow interchange of Spectra 70 input, output, storage or communications units with other Spectra 70 processors.

The multi-lingual capabilities enable the Spectra 70 to "speak" the language of many other computers, including the recently announced IBM 360 as well as the RCA 301, 3301, and 501 systems.

Spectra 70/15

The 70/15 processor, the smallest of the Spectra 70 series, is a general purpose computer designed for small data systems applications, remote terminals, and as a satellite support unit. The character-organized, two-address system extracts and restores information to memory in one eight-bit byte at a time (one alpha-numeric, or two decimal digits, or binary). Each character handled is a standard communication character in Extended Binary Coded Decimal Interchange Code (EBCDIC). Memory cycle time is 2 microseconds per eight-bit byte.

Capable of communicating with all RCA peripheral equipment through a standard interface, the 70/15 provides an orderly, economic transition from conventional batch data processing to the most complex management information installation. Rentals begin as low as $800 a month, offering one of the lowest cost-performance indices in the EDP industry. The minimum configuration solves the small data processing problems, perhaps as complex as a large corporation's but of smaller volume. Linked to a larger number of peripherals, the 70/15 provides medium-class system capabilities at a favorable cost per unit of work.

Spectra 70/25

The 70/25 processor is a general purpose, stored program system designed to satisfy a wide variety of data processing requirements. With its magnetic tape, unit record, and paper tape capabilities, the 70/25 operates concurrently with input/output data transfer. A character organized, two address instruction format is used, instructions being 2, 4, or 6 bytes in length. An extremely fast memory cycle time of 1.5 microseconds per eight-bit byte is provided; however, information can be extracted and restored to memory four bytes at a time. Up to 123 terminals and peripherals can be operated on line.

Ideally suited for computer users desiring to convert from over-taxed magnetic tape or punched card installations, the 70/25 provides configurations that will give excellent service to medium and medium-large installations. The system is fully compatible with the smaller 70/15, and is field-expandable from the minimum storage of 16,384 eight-bit bytes to 65,536. The 70/25 will communicate through standard interface units with all RCA peripheral equipment. Rentals begin at $1,850 a month for one of the lowest cost-performance indices of its range. When augmented by optional peripheral devices, the 70/25 provides medium-large capabilities at a favorable cost per unit of work.

Spectra 70/45

The 70/45 processor is a stored program, general purpose computer designed to serve as the main element of a small-to-medium scale integrated system. Featuring monolithic integrated circuitry, its memory speed is rated at 1.44 microseconds per two bytes (16 bits). The fast data transmission and computation rates of up to 144 instructions assures the 70/45 of highly efficient data processing, communications control and scientific problem solutions. Four optional floating point 64-bit registers are provided. Up to 11-way simultaneity is available through intermix of input/output devices. A 300 nanosecond scratch pad memory provides 43 general purpose 32-bit registers. Fixed length data of 8, 16, 32, or 64 bits may be processed. Variable length data of up to 256 characters in eight-bit byte increments, or up to 16 digits (four bits each) packed two per eight-bit byte, may be processed. Eight-bit characters may be in either EBCDIC or ASCII.

The large storage capacity of the 70/45, coupled with fast data transmission and computation rates, makes this system highly efficient as both data processor and a scientific problem solver. The 43 general purpose registers are used for base address, index or utility registers, with separate scratch pad registers for use in the interrupt and executive systems. With a monthly rental of $3,600 minimum, a low-cost per unit of work is achieved. Augmented by optional peripheral equipment, the 70/45 reaches the large-scale range and offers one of the lowest cost-performance indices in the data processing industry.

Spectra 70/55

The 70/55 processor is a word organized, stored program, general purpose computer

intended as the main element of a medium-to-large integrated management system. Featuring monolithic integrated circuitry, the 70/55 provides complete programming compatibility with the 70/45 processor. The extremely fast memory cycle time of 840 nanoseconds for four bytes (32 bits) is coupled with huge memory capacities of 65,536; 131,072; 262,144; or 524,288 bytes. Fixed length data of 8, 16, 32, or 64 bits may be processed. Variable length data of up to 256 characters in eight-bit increments, or up to 16 digits (four bits each) packed two per eight-bit byte, may be processed. Eight-bit characters may be either EBCDIC or ASCII.

The 70/55 is designed for all electronic data processing applications. The huge storage capacity coupled with 14-way simultaneity and parallel logic implemented by integrated circuitry, make the 70/55 directly applicable for total management operation. The 300 nanosecond scratch pad memory provides 43 general purpose 32-bit registers, while double precision floating point arithmetic offers a wide range of data processing and scientific capabilities. Monthly rental for the 70/55, ranging from a low of $8,350 to a processor with the largest memory at $22,550, gives the 70/55 a low cost-performance index in its range.

INPUT/OUTPUT

The flexible concept of the RCA Spectra 70 Series is to provide a complete spectrum of data processing in one family of equipment. The range of input, output, and terminal capabilities available in the Spectra 70 family implements that concept.

With a choice of more than 40 peripheral devices, the Spectra 70 user, regardless of the size or sophistication of his data processing requirements, can implement the precise system he needs and evolve to other stages easily and economically.

Because of their multi-lingual talents, members of the Spectra 70 computer family can communicate effectively with the wide variety of media and devices available in the overall family—punched card, punched paper tape, optical character reader, magnetic tape and mass storage units, and communications equipment.

Standard input/output interface allows Spectra 70 input, output, storage, or communications units to function with other Spectra 70 processors and at the same time provides for easy interchange of units.

High and medium speed data channels, and standard multiplexor and communications multiplexor channels are available to permit a broad mix of functions and in the number of units reporting to the central computer system.

The Spectra 70/15

This small but powerful computer can serve as a flexible communications terminal in a larger information system—a low-cost, high-speed controller for large volume input/output operations, either as a remote communications terminal or off-line satellite.

Via six input/output trunks, the Spectra 70/15 communicates through a standard interface with all Spectra 70 input, output, storage, and communications equipment.

With a memory capacity ranging from 4,096 to 8,192 eight-bit bytes, the memory cycle is 2 microseconds per byte.

Triple Purpose Transport

A single versatile, low cost unit provides a combination of optical reading with mark read and card read options.

The Spectra 70/251 Videoscan Document Reader teams television scanning techniques and a flexible, high-speed data processing transport. The transport mechanism handles documents ranging from 2-1/2 by 2-1/2 inches to 4 by 8-1/2 inches, on either paper or card stock. The unit reads numerics and special symbols in the RCA N-2 font printed by a variety of methods—computer or typewriter output, pre-printed forms, or data printed from plastic cards.

A demand reader, the 70/251 employs a unique vacuum drum to assure error-free selection of the next sought-after card, on computer command and with minimum wear and tear on the individual cards. Operating speeds are 1300 documents per minute on a demand basis and up to 1800 documents per minute on a continuous feed basis. The 70/251 "reads" up to 500 standard 80-column cards per minute, handling punched card holes, pencil marks, or both in combination in a single pass.

A 50 percent reduction in scientific problem solving and card processing times is made possible by an optional column binary mode. Input hopper, output stacker, and the selective stacker each hold 2000 cards, and can be loaded or unloaded while the reader is in operation.

Entry and Display

Video interrogation and display systems are an integral part of Spectra 70's real-time capabilities. They make possible real command and control techniques for business by providing the ability to get facts where needed, instantly.

Spectra 70 Video Data Terminal and Interrogator units operate directly with the central computer complex through buffered communications channels over a variety of common carrier facilities.

The Spectra 70 Video Displays provide up to 480 character messages on a 14-inch cathode ray tube from a selected subset of 48 alphanumeric characters.

The interrogating keyboards provide the ability to write a message on the video display which can be corrected by retyping. Once the message on the screen is correct, the entire message or inquiry is sent to the computer by pressing a single button.

The Spectra 70 entry and display systems:

6050 Video Data Terminal—a complete unit which combines data entry and display. The terminal operates over its own communications line and contains its own storage and character generator, capable of providing a selected 48-character subset for display of up to 480 characters on its 14-inch screen. The 6050 is available with two data transmission rates—one for 105 to 180 characters-per-second transmission and the other operating at 10 characters-per-second.

6051 Video Data Interrogator—an entry and display device that operates under control of a model 6077 Interrogator Terminal. The 6051 provides the same character display as the 6050.

6077 Interrogator Control Terminal—provides facilities for operation of up to eight 6051 Video Data Interrogators on a single line, performing the required communications with the system. The 6077 makes provision for 480-character display and has a 48-character alphanumeric-character generator. The unit provides up to 16 standard callable formats for automatic allocation of information to prescribed positions on the video screen of the 6051 units.

Other Key Units

High-speed communications control: for long distance inquiry servicing and memory-to-memory linkage with other Spectra 70 and RCA 301-3301 processors.

Data Exchange Control: for local memory-to-memory linkage with other computers.

Multiplexor communications control: for multi-line digital data networks.

Modular random access: RCA 2888 mass memories, data drum memories, data disc devices.

60,000 and 120,000 byte-per-second magnetic tapes with mix tape controls: seven-level industry-compatible code options from 15,000 to 60,000 and 30,000 to 120,000 characters.

High-speed card readers: image mode, mark read options.

Buffered card punches: 100 cpm with image mode option, and 300 cpm with image mode and read/punch options.

Paper tape reader/punches: six-level advanced sprocket hole option.

Medium-speed, high-speed buffered line printers: 160 column option.

General Purpose Fluid Element Digital Computer

UNIVAC
New York 19, New York

Sperry Rand Corporation's UNIVAC Division announced and demonstrated an experimental general-purpose, fluid-operated digital computer.

Air flowing to 250 molded plastic switching elements through a complex network of channels enables the new experimental system to carry out the four basic computer functions: memory, Arithmetic, Control, and Input/Output.

Although there has been much fluid amplifier research and development during the past few years, most work has been limited to

circuit and basic element development. The UNIVAC Fluid Computer represents the first working air-powered system that performs all of the functions and incorporates all of the fundamental logic found in any general purpose computer.

The new experimental system demonstrated in October 1964 has four instructions and four words of memory. Each word is four bits long. Operation is bit parallel.

To simplify construction and testing of the UNIVAC Fluid Computer, the system has been divided into two parts. Each part consists of a power supply manifold and three rows of NOR elements. There are 280 circuit elements in the unit. Existing functions require 250 NOR elements. The extra elements are included for possible extensions to the logic.

The NOR element power inputs are plugged directly into the manifold. Circuits are completed by simply connecting one of the four outputs of an element to one of the four inputs of the next logical element in the circuit. These connections are made with plastic tubing.

One side of the computer contains the clock, step counter, instruction portion of the static register, function table, and "A" register circuits. The other side contains the control counter, address portion of static register, memory select, and memory counter.

Each half was wired and tested independently. Simulated pressure signals were used for testing the circuits on each side. When both sides were working separately all of the cross connections between the two sections were made, and appropriate outputs were connected to the control panel indicators. To facilitate maintenance one side hinges out, exposing all of the internal circuitry.

Computing Centers

Center for the Study of Information Processing

Carnegie Institute of Technology
Pittsburgh, Pennsylvania 15213

Center for the Study of Information Processing has been established at Carnegie Institute of Technology through a more than $3 million contract from the Advanced Research Projects Agency (ARPA) of the Department of Defense.

The new center will utilize Carnegie Tech's computer facilities which includes a paired computer with the second largest "memory storage" of any machine in industry or education in the United States. In addition, it is expected that another computer, making a total of five, will be shortly added to the computation center. Tech also currently has 12 teletype units at various places on campus from which research projects can be conducted on the computer, and it is expected that by the end of this year, 30 such units will exist in various departments and residence halls on campus.

According to Dr. Alan Perlis, director of the computation center, and Dr. Allen Newell, institute professor of systems and communications sciences, all intellectual activity presumes information processing and all systems require communication and control. The importance of understanding information processing stems from the fact that it pervades and interpenetrates all other fields.

The fundamental aim of the center is the understanding of the nature of information processing—that is, the systems which process and transform information, and the way it is used to control, integrate, and coordinate other systems. The value of such an understanding to ARPA is found in the great need for anticipated demands and quick response of which only the computer is capable.

Dr. Perlis visualizes the center as using the computer as sort of a "public utility" similar to power companies in that it would provide its facilities to fit individual needs of many simultaneous users. Future plans, in fact, call for a system installed by the Bell Telephone Company whereby the Tech computer will be available for problem solving by any qualified person anywhere in the United States.

Organizationally, the center will consist of a small number of full-time faculty and a large number of joint appointments and non-paid faculty users of the computation center's facilities. A two-story structure which will add another 6000 square feet to the center, was to have been completed by November 1 for use by new staff members. It is expected that by 1966-67, the annual budget of the new center will be about $1,800,000 with the equivalent of almost 100 full-time persons being employed.

Currently at Tech, computers are being used for research projects in all departments of the College of Engineering and Science, in the behavioral sciences, in management sciences, in human thought simulation, in the fine arts, and in the new systems and communications science program which cuts across traditional disciplinary lines, and which has already received over $1 million of ARPA support. Other current users of Tech's computer facilities include Mellon Institute and the Bureau of Mines at Bruceton, both of which can use the facilities from remote units located in their buildings.

Dartmouth Time-Sharing System

Computation Center
Dartmouth College
Hanover, New Hampshire

INTRODUCTION

The Dartmouth College Computation Center operates a Time-Sharing computer system that can simultaneously service a large number of remote consoles. This system is used both for teaching large numbers of undergraduate students, and for faculty research purposes. It was designed and the software constructed in a relatively short time by a small group of faculty members ably assisted by a highly qualified and enthusiastic group of undergraduates. The Dartmouth Time Sharing experience shows two facts: First, Time-Sharing should be considered not only for major research and teaching Centers but also for smaller and more conventional installations. Second, the nature of the programming and systems problems connected with Time-Sharing are now fairly well understood and present less difficulty than was previously anticipated.

EXTERNAL DESCRIPTION

The Dartmouth Time-Sharing hardware complex contains two computers. One is the General Electric Datanet-30, which is used both as the remote console controller and also as the site of the master executive program. It can control, through interrupts, the other computer, a General Electric GE-235, whose main function is to perform floating point arithmetic. There is a direct line connecting these computers, which is used for control purposes. The main path of the data and information transfer in both directions, however, is through a disk storage unit which can be accessed by either computer. In addition to its role in handling information flow between the two computers, the disk provides a storage for both active and save programs.

The multiple remote consoles are model 35 teletype machines; however, the equipment can handle almost any type of remote device employing standard codes transmitted at relatively slow rates.

The computer complex also includes conventional tape drives, card reader, card punch, and high-speed printer. These devices, however, play only an ancillary role in the Time-Sharing System.

USERS DESCRIPTION

The user introduces himself to the system by typing the word HELLO. This initiates a short series of questions and answers which serve to further identify the user and his problem. Specifically, the user supplies his user number, the name of the system with which he intends to operate, specifies whether the problem he is about to name is new or old, and gives the problem name. If it is an old problem this system retrieves it from the saved program storage area on the disc. The user may then add to the program or modify it in any way. If it is a new problem, the user is presented with a clean slate, and he composes his program from scratch.

The statements of the program start with a line number, which distinguishes them from the commands to the system. Having the user type his own line numbers permits him to correct lines in the program simply by retyping them, to insert new lines in the program, or to delete unneeded lines. When he has finished composing his program, he then types RUN without a line number. This command causes the system to deliver his source program to a translator, after which it is run. The answer will then be typed out on the teletype machine.

Other commands are available to the user. By typing SAVE the user can store away for future reference his program as it exists at that moment and under the problem name he is currently using. Such saved programs can be later retrieved by typing OLD. If the user is finished with his saved program, he should type UNSAVE, which makes available that particular storage space for some other program. At any point he may type LIST, which will list his entire active program, or LIST—XXXX, which will list his program starting with line number XXXX. At any time in the proceedings the user may type STOP. Even if the system is printing out answers or listing a program, it will immediately stop and wait further commands. The combined use of the selective LIST and the STOP commands permits the user to easily list single lines in the middle of his program.

At any time the user may specify a new system. The effect is to move into the last half of the HELLO sequence where he selects NEW

or OLD and then gives the problem name. He may also at any time specify NEW or OLD, and then give the new or old program name. The command RENAME, which simply replaces the old problem name with a new name, allows the user to generate easily two most identical versions of the same program. He would retrieve the first, rename it, make slight modifications, and then save the modified version under the new name. SCRATCH permits the user to erase all the lines in his program and start out with a clean slate. RENAME plus SCRATCH, in either order, is equivalent to NEW.

A user may obtain a complete listing of all programs saved under his user number by typing CATALOGUE. Such a listing is useful not only for users having a large library of saved programs, but also for users who might forget the spelling of their problem names.

Currently under development are two new commands RENUMBER and MERGE. MERGE will permit a user to retrieve two or more saved programs to create a larger composite program. RENUMBER will permit the user to renumber the lines in any program to permit later merging with programs having similar line numbers.

INTERNAL DESCRIPTION

The system may be divided logically into three parts. The Datanet-30 computer acts as a remote console controller but more importantly contains the master executive program. The GE-235 performs all translations and executions, and certain bookkeeping operations as well. The disc storage unit acts as the buffer area for currently active programs, the buffer area for information being outputted from the GE-235, and as a storage unit for save programs. It also serves as the storage unit for the various systems used in the 235.

Inside the Datanet-30 are input-output buffer areas associated with each teletype station. These are operated in a flip-flop fashion so that input or output typing may continue in one part of the buffer while the other is "connected" to the disc unit. The program in the Datanet-30 is divided into two parts, a real-time part and a spare-time part. The real-time part is entered via clock controlled interrupt 110 times per second in order to scan the teletype lines. As characters are completed, the real-time part collects them into messages and, when a "return" character is encountered, interprets the message. If it is a line in the program, nothing is done. If the message is a command, a spare-time task to start carrying out the command is set up and inserted in the spare-time task list. If there is not enough time to complete his setting up, the real-time part will complete the set-up during the next real-time period.

The spare-time portion carries out the spare-time tasks, which include mainly disc operations and certain teletype operations. Communication to the GE-235 is carried out in real-time according to instructions generated in spare-time.

In the 235 there is a resident compiler system that acts as a translator, and a resident executive routine to manage the disc input-output operations and to perform other functions. The executive system permits simultaneous use of the card equipment, the tape drives, and the high-speed printer during Time-Sharing through interrupt processing.

The disc unit is divided into three areas. First is the current working area containing the program which the user is either composing or has retrieved. It is this program that is delivered to the 235 when a RUN request is made. The second area in the disc includes the storage area for saved programs. Depending on the size of the program, somewhere between 2000 and 7000 programs may be saved. The third area is a catalogue for saved programs. The catalogue is divided into 100 equivalence classes according to the third and second digits of the user number. Each time a request for a SAVE, OLD, or UNSAVE is made, the catalogue is scanned by the Datanet-30 for either the desired entry or a space into which a catalogue entry for the program may be placed.

Because the rate of information flow between the two computers is disc-bound, the maximum utilization of the 235 cannot exceed approximately 80 percent. Future plans call for a reallocation of the areas on the disc to minimize the average arm movement time, and to possibly cut down the disc overhead time by about 25 percent.

COMPARISONS

The Time-Sharing system is not compatible with the monitor-controlled system as operated at other times during the day. In Time-Sharing, the user has a block of only about 6000 words at his disposal. During monitor operations he has a considerably larger area at his disposal. It is planned, however, to permit a user to compose and debug a program during

Time-Sharing, and then to create an equivalent form for production running during monitor operation.

This system can be accurately described as a small job processing system. At the present time, Dartmouth Time-Sharing does not have the capability for running large complex programs under Time-Sharing. Furthermore, the design of the system as a job processor does not permit it to be designated as a truly real-time system. There can be fairly long waits of from 5 to 10 seconds as the spare time tasks and run requests become stacked up. These stack ups and delays are almost entirely a result of the central role played by the relatively slow disc as an extension of memory. Future systems with large memories need not be so encumbered. Furthermore, relatively simple changes in the master executive program will permit almost any sort of communication with external devices, including the instantaneous sort of response required by laboratory experiment equipment being controlled by the computer.

The Dartmouth Time-Sharing system is, however, extremely effective as a small job processor. The minimum amount of red tape required by the user, and the simplicity of the BASIC language provide an accessibility equivalent to that offered by a desk calculator. In fact, it is often easier to run a trivial calculation through the Time-Sharing system than it is to use a desk calculator, and it may also be easier to use the Time-Sharing system to calculate some tabled quantity than to look up that quantity in the handbook. While such usage may not be an effective use of the teletype consoles, it costs virtually nothing in terms of the machine time used; such an equivalent table lookup can be made for less than one penny.

The Dartmouth Kiewit Computation Center began full-scale operation in September 1964. Professor John G. Kemeny and associate professor Thomas E. Kurtz, the two college mathematicians who led in its planning, feel that users may well be getting the fastest service on research any institution can offer.

They are also confident that few if any institutions now offer faculty and students such easy access to a high-speed computer. Now in operation around the campus are 22 stations which are connected to the GE-235 in the computing center. This enables the college to meet increasing demands for computation by faculty and student research and to teach from 75 to 90 percent of all students the operations, capabilities, and limitations of electronic computers which most will be using in their careers.

<u>BASIC</u> - <u>B</u>eginners' <u>A</u>ll-purpose <u>S</u>ymbolic <u>I</u>nstruction <u>C</u>ode

To connect your teletype to the Time-sharing system, press the ORIG key. If you hear a tone (speaker should be turned up), and then no tone, you are ready to enter the Hello sequence. In the Hello sequence shown below, lower-case letters are used to indicate systems output and upper-case for user's input. Incidentally, to disconnect your teletype from the Time-sharing system, press the CLR key.

```
HELLO ®
User number -- S100000 (must be 6 digits or 1 letter and 5 digits) ®
System -- BASIC ®
New or old -- NEW (unless problem has been saved) ®
New problem name -- EXAMPL   (any 1 to 6 characters) ®
```

```
All state-   (10      PRINT "X", "SINE X" ®
ments re-    (20      READ X ®
quire a      (30      LET F1 = X ®
numeric      (40      LET F2 = 1 ®
label no     (50      FOR F = 3 to 19 STEP 2 ®
more than    (60      LET F2 = F*(F-1) * (-F2) ®
5 digits &   (70      LET F1 = F1 + (X ↑ F/F2) ®
no spaces:   (80      NEXT F ®
             (90      PRINT X, F1 ®
             (100     GO TO 20 ®
             (110     DATA 1.5707, 1.0471, .7854, .6283 ®
             (99999   END ®
```

	(LIST ↵	(--XXXXX to list your program beginning at statement No. XXXXX)
Without	(RUN ↵	(if you want your program to run)
statement	(STOP	(if you want printing to stop)
labels:	(SAVE ↵	(if you want your program saved for later use)
	(UNSAVE ↵	(if you want to destroy a previously saved program)
	(CATALOG ↵	(if you want the names of programs saved for a user number)
	(NEW ↵	(to erase current program and to start a new program)
	(OLD ↵	(if in the Hello sequence, would search for saved programs)
	(SCRATCH ↵	(erases a current program but retains the name)
	(RENAME ↵	(if you want to rename a program)

Return Key ↵ - Will not print on hard copy
←Key - Erase one character for each back error (spaces are considered characters)
Alt. Mode Key - If pressed will erase an entire line.

Variables are single letters possibly followed by a single digit. A number may be up to nine digits.

A line of print may contain five zones of fifteen spaces each. Variables printed will be no more than six significant spaces each, except for integers. Any trailing zeros after the decimal point are not printed. For numbers less than 0.1, the form X.XXXXXX E - Y is used unless the entire number can be printed as a six decimal number; i.e., .03456 is exact: 3.45600 E - Z has been rounded. If the number is an exact integer, the decimal point is not printed. Integers of up through 9 digits are printed in full.

<u>Hierarchy of Arithmetic Operators</u>: 1) The expression inside a parenthesis pair is computed before the parenthesized quantity is used in further computations; 2) Raising to a power is computed before multiply and/or divide which in turn are computed before addition and/or subtraction, in the absence of parenthesis; 3) Several arithmetic operators of the same order are computed from left to right.

<u>Correction to a Program</u> - (For explanation of error messages see Pages 53 & 54 of BASIC MANUAL).

Changing a line -- Type it correctly with the same line number.
Inserting a line -- Type it with a line number between those of the two existing. BASIC sorts your program statements for you.
Deleting a line -- Type the line number only, followed by the "Return Key".

<u>Summary of the 15 BASIC Statements</u> - In this summary it is assumed that all statements begin with a line number. Following each is one example.

LET — LET <variable> = <expression>, i.e., 10 LET X1 = Y + Z + (Z/A - B ↑ D1)

READ — READ <variable>, <variable>, . . . , (variable) i.e., 10 READ X, Y, A1, Q (I, J)

DATA — DATA <number>, <number>, . . . <number>. i.e., 1, 2, -3, 7, 123.479, -2.35-4

PRINT — PRINT <label>, or <label> <expression>, or <expression>
10 PRINT "SINE", "X (I, K), A + B*CØS (Y)

GØTØ — GØTØ <line number> i.e., 10 GØTØ 17

IF-THEN — IF <expression> <relational> <expression> THEN <line number> i.e., 10 IF X + Y >0 THEN 419

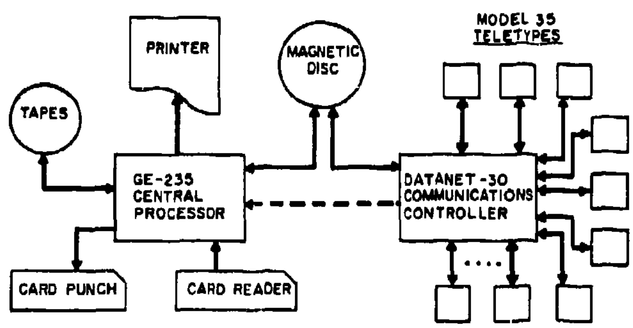
FØR — FØR <unsubscripted variable> = <expression> TØ <expression> STEP <expression>
10 FØR I = 1 TØ 17 10 FØR X1 = 0 TØ 7 STEP 0.5

NEXT — NEXT <unsubscripted variable> i.e., 10 NEXT X1

END	END i.e., 10 END
STØP	STØP i.e., 10 STOP
DEF	DEF FN <letter> (<unsubscripted variable>) = <expression> 10 DEF FNG(Z) = 1 + SQR(1 + Z * Z)
GØSUB	GØSUB <line number> i.e., 10 GØSUB 110
RETURN	RETURN i.e., RETURN
DIM	DIM <letter> (<integer>), or <letter> (<integer>, <integer>) 10 DIM A(17), B(3, 20)
REM	REM <any string of characters whatsoever> 10 REM THIS IS THE END OF APPENDIX C

BASIC has available to the user the following functions:

FUNCTIONS	PURPOSE	
SIN (X)	Sine of X	
COS (X)	Cosine of X	
TAX (X)	Tangent of X	X must be in radians
ATN (X)	Arctangent of X	
EXP (X)	Natural exponential of X, c^x	
ABS (X)	Absolute value of X, $\|X\|$	
LOG (X)	Natural logarith of $\|X\|$	
SQR (X)	Square root of $\|X\|$	
RND (X)		
INT (X)		



Schematic diagram of system hardware

Overseas AUTODIN Installations

U.S. Army Electronics Command
Fort Monmouth, New Jersey

The U.S. Army Electronics Command, Fort Monmouth, has awarded Philco Corporation's Communications and Electronics Division a $31,381,167 contract to provide 10 overseas installations for AUTODIN, the Defense Department's high-speed digital communications system.

The AUTODIN (AUTOMATIC DIGITAL NETWORK) contract requires Philco to design fabricate, install, test, maintain, and operate for 1 year the 10 overseas centers. Equipment for a military instructor and operator training center at Fort Monmouth also will be provided.

The new AUTODIN centers will permit world-wide teletype and high-speed digital data communication, and will enable computers literally to "talk" to each other. Information at each center can be handled at rates up to 3000 words per minute. The digital signals used in AUTODIN take up less space in transmission and can be transmitted faster than voice signals. Digital signals are a cacophony of sounds to the human ear and require electronic equipment to convert them to usable information at the receiving end.

The AUTODIN centers, through the use of electronic equipments, carry out the vital function of handling messages and data information traffic and speeding its flow from center to center on a world-wide system. Each center stores messages and retransmits them to the designated destinations as soon as transmission lines are available. Messages are processed on a priority basis and top priority messages are transmitted without delay.

The two magnetic drums used at each switching center will store more than 2 million words each and the 10 magnetic memories at each center will each store 16,000 words.

To insure continuous operation, a special switch function at each center will automatically replace any part of the system that fails.

The AUTODIN contract is administered by and under the technical supervision of the Army Materiel Command's UNICOM/STARCOM Project Manager, Col. H. F. Foster, Jr., Fort Monmouth.

While the contract was awarded by the U. S. Army's Electronic Command, the Defense Communications Agency's Defense Communications Engineering Office will operate AUTODIN.

Associated with the C & E Division in the contract will be Philco's TechRep Division, which will be responsible for installing and testing the equipment in the 10 centers, and for maintaining and operating them for 1 year after the first center is completed.

Each Automatic Digital Message Switching Center (ADMSC), as they will be officially known, will contain:

- An automatic digital switch, which is essentially a grouping of high-speed data processors.

- A communications subsystem known as Technical Control, whose major function is to maintain service continuity to other connected switching centers and tributaries.

- An uninterrupted power supply.

The 10 ADMSC's will be located in Alaska, France, Germany, Guam, Hawaii, Japan, Okinawa, Panama, Philippine Islands, and the United Kingdom.

The centers will eventually replace separate facilities now maintained by the U.S. Army, Navy, and Air Force. They will be located in new air-conditioned buildings, for which Philco will prescribe architectural and engineering standards.

The Company initially will design and build a pilot model, which will be installed at Willow Grove for testing and evaluating systems effectiveness.

Two Computer Link

Computing Center
Yale University
New Haven, Connecticut

The Yale University Computer Center took a step in September 1964 toward meeting the burgeoning demand for its services when it put into operation a new system linking together

two high-speed computers—one acting as the "manager" and the other as the "brains" of the team.

The changeover points up the critical importance of the computer in a modern university where researchers not only in the sciences but in the arts, music, and linguistics have been waiting in line to use the electronic calculator.

Until it was shut down in August to make way for the new equipment, Yale's bread-and-butter computer, an IBM 709, had been running 24 hours a day, 7 days a week trying to keep up with demand. Even at that, the workload had become so heavy that users often had to wait anywhere from 6 hours to 2 days to obtain results of their programs.

This situation developed over the past several years despite the fact that the 709 is no slouch as computers go—with its electronic memory of more than 32,000 36-bit words, it can do 40,000 additions of 10-digit numbers a second.

The Yale Center's new IBM Direct Coupled System will reduce waiting times of 24 hours and more to 5-30 minutes, depending on the number of persons using the facilities at one time.

According to Center Director Morris S. Davis, the system, one of the most advanced at any university, actually will solve half the problems fed into it in 12 seconds or less, with additional waiting time being consumed by clerical routine.

The agent of all this efficiency is two high-speed, solid-state computers linked together in a division-of-labor arrangement. One computer, an IBM 7040, is the "manager" of the team. It controls input-output operations for the "brain" of the partnership, an IBM 7094, which solves problems at fantastic speed while its manager handles such housekeeping chores as checking and scheduling programs, storing and retrieving information, and controlling card-punches and two high-speed printers.

Although each of the new computers, when used alone, calculates 7 to 10 times faster than the 709, they are even more efficient when linked together. The reason is that the coupling arrangement relieves the "brain" of a host of support operations that slow down a single computer, and also because the new computers can handle more problems simultaneously.

The 7040 "manager can handle up to six programs at once—for example, processing data on problem C while transcribing problem E from punched cards to magnetic tape while printing the results of problem A at 600 lines a minute.

The new computers are both fully transistorized, which means that they run cooler than the vacuum-tube 709 while occupying the same floor space. If one should break down, the other can be run alone.

Even though use of the Computer Center is expected to increase about 430 percent in this academic year, the new system would be able to handle a normal day's work in a few hours. The Center, however, will remain open from 8:30 a.m. until 1 a.m. the next day, for the convenience of students and faculty who must work at night.

The reason for the immediate surge in computer use is twofold—use of computers is increasing rapidly at Yale because programs are being expanded, and many programs now being carried out at other computer installations will be transferred to Yale.

Besides the Direct Coupled System, the Center will retain three smaller computers for use on less complex problems, and for teaching programming and computer science. These are an IBM 1401, an IBM 1620, and an IBM 610.

The 709 computer, which the University bought 3 years ago with a grant of $500,000 from the National Science Foundation, has been put in storage. Yale is leasing its new $4.5 million system from IBM with an option to purchase it.

The growth of the Computer Center since it was established in 1957 has been phenomenal, and has been in response to an ever-increasing demand from practically every area of University life for faster computing facilities.

No longer the exclusive tool of the scientist and engineer, the computer has become a valuable, even essential, research aid in nearly every academic discipline, from anatomy, biology, and chemistry to law, music, medicine, political science, and the humanities.

Mr. Davis, an astronomer when not directing Center operations, traced the birth of the Center to the use of punched-card installations by several departments during the late 1940's to carry out a variety of problems.

Among the early users of these machines, which already have become museum pieces, were Astronomy, Sociology, and the Cowles Foundation for Research in Economics.

Demand increased steadily, however, and in 1957, with the assistance of a $20,000 grant from the N.S.F., the University opened a Computing Center in the Observatory Building on Prospect Street. The Center's main computers were an IBM 650 and an IBM 610, purchased in 1959. The first leap forward came in 1961, when the new Center with its 709 computer was dedicated.

The growth of computer use at Yale has not been confined to the Computer Center. The departments of Industrial Administration and Engineering and Applied Science have their own 1620's, while the Physics Department has a Digital Equipment Corp. PDP-1 and is planning to get another. Several departments that are heavy users of computer facilities have their own card punches and sorters.

The office of the University treasurer recently installed an IBM 1401 to process records, while another 1401 will be installed in the new Laboratory of Epidemiology and Public Health at the School of Medicine when the building is completed in December.

This machine will be under the direction of the Computer Center, and is expected to receive heavy use from such departments as Psychology, Psychiatry, Anatomy, and Epidemiology, and Public Health.

For the future, there is the possibility of remote input stations in various departments linked to the Center, so that users could communicate with the DCS without leaving their offices. In fact, a proposal is being studied to tie in the 1401 computer at the Medical School to the Center so that it can be used as a remote station.

Another linking arrangement that would tie the DCS to the control computer at the University's Nuclear Structure Laboratory also is being considered. This link would enable the DCS to accept and process output "overflow" from the accelerator's computer.

Although scientists and engineers are naturally the Center's biggest customers, with physics, astronomy, and chemistry heading the list, the computers are being applied to some less obvious areas of scholarship, including art, the humanities, music, and even philosophy.

Some of these projects include studies of theory proving in philosophy, statistical investigations in art and music, a computer analysis of musical sounds, and a comparison of Polynesian languages. The Graduate School is studying possible uses for the computers in the humanities, while the Medical School Library is cooperating with Harvard and Columbia in developing a high-speed computer system to replace cumbersome card catalogues.

One area where Mr. Davis hopes to see expansion is in computer science—the study of computers. Courses are now offered on both the graduate and undergraduate levels in engineering, and to undergraduates in astronomy. In addition, the Computer Center offers a 12-hour, non-credit course in programming that is repeated often through the academic year.

Computers and Centers, Overseas

Current and Future Equipment

Commonwealth Scientific and Industrial Research Organisation
Computing Research Section
Canberra City, Australia

The Computing Research Section of the Commonwealth Scientific and Industrial Research Organization has a dual aim. Firstly, it undertakes research into numerical techniques, language translation, and other applications. Secondly, it provides computing facilities for all the Divisions within C.S.I.R.O. and for Departments of the Commonwealth Government. The system consists of a central computer at Canberra, and satellite computers at Adelaide, Melbourne, and Sydney.

COMPUTING EQUIPMENT

The Canberra installation comprises a Control Data 3600 computer with a 32,768 word core store and cycle time of 1.5 μsecs, eight magnetic tape units, card reader, card punch, two paper tape reader/punch units, two printers at 1000 lines/min., one printer at 150 lines/min., and two Calcomp incremental graph plotters, one for 30-inch and one for 12-inch paper.

The equipment at each satellite comprises a Control Data 3200 computer with a 16,384 word core store and a cycle time of 1.5 μsecs, three magnetic tape units, card reader, card punch, paper tape reader/punch, one 1000 lines/min. printer, one 150 lines/min. printer and one Calcomp 12-inch graph plotter.

FUTURE DEVELOPMENTS

In order to improve the throughput rate and return times for program development, the installation at Canberra is shortly to be modified by the addition of 2 million words of drum storage and a number of on-line display consoles with keyboards.

The system envisaged will make intensive use of the drums. The average core-drum transfer loading factor may be as high as 50 percent, i.e., transfer in progress for 50 percent of the operating time, when the drum would be equivalent to 2 million words of 10 μsec core store for an apparent mean increase in the internal core cycle time from 1.5 to 2.0 μsec.

Each C.R.T. display unit will show a "page" of about 500 characters. The first stage of software implementation will allow all the console users to create, edit, and execute program files, at stated priorities, in a time shared manner between the consoles and the normal serial job stack. This initial objective will allow for future development of console usage to on-line computation, symbolic processing, and creation of new processing systems for specialized languages and application areas.

In addition to the keyboard console displays, one larger high definition general purpose C.R.T. display will be installed. This will be provided with a large internal buffer store and light pen facilities. The internal control systems will allow brightening and blanking of any chosen areas of the display pattern without continuous control by the C.P.U.

English Electric-Leo Computers

English Electric Co., Ltd.
London, England

The English Electric Company Limited, London, England, has agreed to purchase J. Lyons & Company's shareholding in English Electric-Leo Computers Limited for approximately $5.2 million.

English Electric-Leo Computers now becomes a wholly-owned subsidiary within the English Electric Group. The shareholding being acquired from J. Lyons & Company Limited will be transferred to the Marconi Company

Limited, English Electric's principal electronic subsidiary company.

The computer company will now be known as English Electric Leo Marconi Computers Limited.

English Electric-Leo Computers Limited was formed by the merger of Leo Computers Limited with the Data Processing Division of The English Electric Company in April 1963.

Among the company's scientific and industrial computers are: the KDF 9 high-speed computer, the fully-transistorized KDP 10, the small KDN 2 industrial control computer, and the Leo series of data processing machines.

I.C.T. 1900 Series Computer Systems

International Computers and Tabulators, Ltd.
London W1, England

INTRODUCTION

International Computers and Tabulators Limited announce the I.C.T. 1900 Series—a comprehensive range of compatible computer systems. This flexible new range gives the user freedom to augment or modify his installation to meet changing requirements, without sacrificing his investment in programming or in peripheral equipment. As the user's computing needs change, the I.C.T. Standard Interface provides the facility for the central processor or peripheral units of the I.C.T. 1900 Series to be replaced, simply and rapidly.

Within days of the launching of the I.C.T. 1900 Series, British executives and visitors to this country were able to examine the new equipment in operation at the Business Efficiency Exhibition which opened in London on October 6, 1964. Deliveries will begin within a year.

The 1900 Series ranges from a basic configuration costing £40,000 for routine accounting, for example, to more sophisticated systems suitable for the most complex commercial and scientific work, costing £750,000 or more. In all, seven central processors will be available.

The introduction of this new range puts the British computer industry in a strong competitive position in world markets.

COMPATIBILITY

The I.C.T. 1900 Series is designed around the concept of Standard Interface through which standardized sets of signals transfer information between processors and peripheral devices. Thus, it is a simple operation to attach peripherals to all existing processors; conversely, a more powerful central processor may be substituted and the existing peripheral units retained.

The flexibility of this technique allows for the tailoring of each system to meet the present needs of the user, and yet permits the system to be modified easily and quickly to satisfy changing requirements.

Comprehensive and simple programming languages, common to every central processor in the series, are available. A program written for the smallest system will run on the largest.

TECHNICAL ADVANCE: MULTI-PROGRAMMING

Five central processors in the series incorporate the multi-programming technique developed by I.C.T. This means that several tasks can be carried out simultaneously, without mutual interference. As a result, the productivity of these computers is substantially increased.

SIMPLE OPERATION

Communication between the operator and the computer is simple. A typewriter passes instructions to the computer in plain language and, from there, 'Executive' (the Master Program) takes over. 'Executive' is a special program devised by I.C.T. which supervises the operation of the system for the user and helps to eliminate human error. It arranges priorities, reports on the progress of jobs and the state of peripherals, controls the transfer of information and oversees the functions of each device in the system. Information for the operator is fed back by the typewriter. The typescript of the dialogue between operator and computer can be retained for reference.

PERIPHERALS

The very comprehensive range of storage, input and output devices includes a Magnetic Card File—a random access device, capable of giving rapid access to more than 2,500 million characters filed away on flexible plastic cards. Printers capable of printing up to 1,350 lines a minute are available. Interesting additions to the peripheral equipment are devices which plot graphs from information fed from the computer, and others which display information on screens resembling television receivers.

Embodied in the concept of the 1900 Series are two features of major technical importance—Executive and Standard Interface.

EXECUTIVE

Executive is a supervisory program that is supplied with every central processor of the 1900 Series. Executive performs the following functions automatically:

It controls the interpretation and execution of commands received from the operator.

It provides him with information on any incidents encountered during the running of programs, and reports on the status of peripheral devices. All communications between the operator and the computer are via a console typewriter.

The peripheral units of the 1900 Series are designed for autonomous operation. Executive initiates and controls the transfer of data between the central processor and the peripheral units, checking that such transfers have been completed successfully. By virtue of their autonomous operation a high degree of simultaneity can be obtained.

In addition, Executive enables the more powerful central processors of the 1900 Series (that is, the 1904 and above) to handle multiple programs concurrently. It allocates peripheral devices and information storage capacity to the programs as they are loaded onto the machine, and ensures that they do not interfere with one another. It also controls the switching from program to program so that waiting time on the processor and peripherals is reduced to a minimum.

Executive increases the operational capabilities of 1900 Series computers without a concomitant increase in the technical complexity or quantity of electronic equipment required in a system.

STANDARD INTERFACE

The 1900 Series system has been designed so that any peripheral device can be coupled to any central processor: this has been made possible by the provision of standard interface.

The principle established is that in order to achieve interchangeability between peripheral units of different types, it is necessary to standardize the format in which data and control signals are transmitted between the central processor and the various peripheral units. In the 1900 Series, the basic unit of data selected for this purpose is the six-bit character.

In turn, this means that every peripheral device has to be provided with facilities for assembling and handling data in this format, and the electronic control unit needed for this task is located in the peripheral itself, and not in the central processor as has been the custom hitherto. Some control units are designed to control the operation of several like devices.

The cable connecting a peripheral unit to the standard interface can be of any length up to 100 feet. Auxiliary equipment can therefore be positioned as free-standing units anywhere within this radius of the central processor.

CENTRAL PROCESSORS

There are seven 1900 Series central processors. All these operate with a word of identical length (24 bits) and all obey instructions of identical format. Hence these units are fully compatible.

The two smallest processors, the I.C.T. 1902 and 1903, can handle one program at a time. Each program can, however, contain two sub-programs. If equipped with communication units, these machines can operate in the real-time mode.

I.C.T. 1904 and 1905 central processors can handle up to four main programs concurrently. Two sub-programs may be associated with every main program. The 1905 is equipped with an autonomous floating-point arithmetic unit.

I.C.T. 1906 and 1907 central processors can handle up to 16 main programs simultaneously, and up to 3 sub-programs may be incorporated in each main program. The 1907 is equipped with an autonomous floating-point arithmetic unit.

Table I. 1900 SERIES—CHARACTERISTICS OF CENTRAL PROCESSORS

Characteristics	Central Processors						
	1902	1903	1904	1905	1906	1907	1909
Core store cycle time (micro-seconds)	6	2	2	2	1.1 or 2.1 up to 1.25 or 2.25 average for largest core store	1.1 or 2.1 1.25 or 2.25	6
Core store size, words[a]	4,096 8,192 16,384	8,192 16,384 32,768	8,192 16,384 32,768	8,192 16,384 32,768	32,768 by 32,768 to 262,144	32,768 by 32,768 to 262,144	16,384 32,768
Data channels (maximum)							
slow	-	-	18	18	18	18	18
fast	-	-	5	5	any number as required		5
general	8	8	-	-	-	-	-
					(At average 1.25 µs cycle time)		
Arithmetic times:							
<u>Fixed point</u>							
add/subtract	18 µs	7 µs	7 µs	7 µs	2.5 µs	2.5 µs	18 µs
multiply	1.5 ms (average)	650 µs (average)	40 µs	40 µs	11.25 µs	11.25 µs	67 µs
divide	2.3 ms (average)	900 µs (average)	44 µs	44 µs	18 µs	18 µs	71 µs
jump	13 µs	5 µs	5 µs	5 µs	2.5 µs	2.5 µs	13 µs
<u>Floating point</u>							
add/subtract	1.15 ms	475 µs	111 µs	13 µs	25 µs	2.75 µs	21 µs
load	-	-	-	6 µs	6.25 µs	2.5 µs	18 µs
store	-	-	-	8 µs	6.25 µs	2.5 µs	18 µs
multiply	5.25 ms	2.25 ms	285 µs	29 µs	60 µs	7.75 µs	37 µs
divide	9.6 ms	3.85 ms	316 µs	51 µs	65 µs	16.75 µs	59 µs
Address modification[b]	6 µs	2 µs	2 µs	2 µs	1.25 µs	1.25 µs	6 µs
Scalar product loop x = x + a; b	6.5 ms	2.8 ms	435 µs	60 µs	103.75 µs	20.25 µs	112 µs
Polynomial loop x's = (x + a)	6.4 ms	2.7 ms	403 µs	42 µs	88.75 µs	10.5 µs	58 µs
Speed ratio for performing typical scientific calculations based on the above loop times	1	2.3	15	126	67	420	76
Number of time-shared programs each with sub-programs	1 2	1 2	4 2	4 2	16 3	16 3	4 2

[a] Word length

Fixed point: 24 binary digits--four alpha-numeric characters.

Floating point: Argument - 37 bits plus sign;
Exponent - 8 bits plus sign.

[b] 1905, 1907, and 1909 processors incorporate floating point unit. Address modification of most floating point instructions takes no extra time due to overlapping of instructions.

I.C.T. 1909 is a central processor specifically developed to provide an inexpensive computer for scientific applications. It has an autonomous floating-point arithmetic unit and can handle as many as four main programs concurrently, each with two sub-programs.

Performance figures for the various central processors are listed in Table I.

MAGNETIC-TAPE UNITS

A range of industry-compatible magnetic-tape units are available with information transfer rates extending from 7,500 characters a second up to 96,000. Data are recorded as characters on tape 0.5 inch wide in a format that conforms with internationally accepted standards. Cluster construction is used for all except the highest speed magnetic-tape units.

RANDOM-ACCESS STORES

Two types of disc store are available. With the I.C.T. 1953 store, data are recorded on a cartridge of six discs. The feature of this store is that the disc cartridge can be removed from the drive mechanism and another cartridge replaced. More than 4 million characters can be stored on a cartridge.

In the I.C.T. 1956 store, the discs are permanently mounted on their drive units. Random-access storage capacity for up to 252 million characters can be provided with stores of this type.

In addition to these two types of disc store, a magnetic-card file—the I.C.T. 1958—is available for use with an I.C.T. 1900 Series system. Cards are held in magazines containing 256 cards, each card storing up to 166,400 characters. An I.C.T. 1958 assembly can provide random-access storage facilities for over 2,726 million characters.

When data are to be transferred to or from a card which is not already on the drum, a positive method is used to select the card which is then extracted from its magazine, and passed round a drum beneath a group of eight read/write heads. The read/write heads can be moved to the required position whilst the card is being fed to the drum, or whilst the card is being rotated on the drum. Data are transferred at 80,000 characters a second. The card will remain on the drum until instructed by the program to return to its magazine. Maximum productivity can be achieved by overlapping selection, reading or writing, and return.

MAGNETIC DRUMS

Three sizes of drums are available with capacities of 32,768; 131,072; and 524,288 words each. Up to four drums of the same size may be connected to a 1900 Series computer system by means of one control unit.

DATA INPUT/OUTPUT UNITS

A comprehensive range of data input/output units is available for inclusion in I.C.T. 1900 Series systems. These include card punches and card readers, paper-tape punches and readers, line printers, graph plotters, visual display devices and a magnetic-ink character sorter-reader.

In addition, various communication units will be available, which will enable data to be transmitted directly between a central processor and remote stations over landlines and other existing communication links. One of the communication devices—the I.C.T. 1995 data exchange control—will permit one 1900 Series central processor to communicate directly with another 1900 Series processor, or an I.C.T. 1004 data processor.

Marconi Myriad General Purpose Computer

Marconi Company, Ltd.
London, England

The new Marconi Myriad ultra-high speed computer will form the basis of the next generation of computers to be produced by The Marconi Company. The Myriad derives from air traffic control and military requirements and combines a number of advanced techniques to provide a desk-size unit which operates at 10 times the speed of computers of comparable complexity currently available. It has therefore 10 times the potential on-line capacity.

This new machine has come about as the result of work carried out by the Marconi Company in the fields of microminiaturized components and ultra-high speed silicon logic circuits. It can perform over 30 million orders per minute. It has been used to demonstrate data handling operations, and simultaneously as an on-line automatic teleprinter exchange with message storage facilities, using the Marconi tabular display system to provide an electronic message display.

The Myriad is based on the use of microminiature silicon diode transistor logic modules with a stage delay time of as little as 5 nanoseconds. The compact construction resulting from the use of these microminiature techniques, is a major factor in the high speed of the computer. The micrologic devices are mounted in type TO-5 modules and printed boards are used wherever possible. Intermodule wiring has been reduced to the absolute minimum, resulting in a computer that is smaller than a normal office desk. The computer works asynchronously and uses a coincident current, ferrite core store which has a capacity of 4096 words. The computer uses a 24-bit word length and has a store access time of 0.4 microseconds and store cycle time of 1.2 microseconds. Thirty-two basic microprogramme orders have been provided and the order speed for fetch, add, subtract, and so on is 2.5 microseconds, and for multiplying, 10 microseconds. The operating panel includes voltage indicators to show the instantaneous contents of each register, as well as keys and switches for computer control and programming.

Connections to peripheral devices are made via data and control highways. An autonomous store access facility allows external devices to have access to the store without interfering with the programme. Normal interrupt facilities are also included to handle up to 15 peripheral devices.

Miscellaneous

Typesetting Computer

The Bunker-Ramo Corporation
Canoga Park, California 91304

Another major step in the use of computers, that of helping to print newspapers more rapidly and accurately than has ever been done before, was announced by The Bunker-Ramo Corporation.

Bunker-Ramo computers are now regularly performing, with previously unattainable results, routine typesetting operations in two Southland newspapers: the Santa Monica Evening Outlook, and The San Diego Union Tribune.

Known as the Bunker-Ramo 230 Comp/Set, this is the first computer specifically designed for use in the composing or typesetting rooms of newspapers. It was made for printers rather than computer programmers with mathematics degrees.

This means that the 230 can accept, without conversion to computer code, the highly specialized terminology of printers, and can carry out involved instructions on the arrangement of newspaper columns, photograph captions, classified advertisements, and headlines.

Now, with only 5 minutes training, printers can prepare the punched paper tape used in setting the newspaper copy much more rapidly than could be done without the Comp/Set. This is because the accuracy and appearance of the lines and columns of the newspaper are automatically controlled by the computer.

Take for example such time-consuming jobs as hyphenating words and keeping both sides of the newspaper column even (justifying). These routine tasks are now done easily and in almost half the time it formerly took to do them manually by the computer.

Comp/Set can retain three different type styles in its memory, and can set 9000 lines of virtually error-free text an hour, almost 20 times faster and infinitely more accurately than could be done manually.

In addition, the Comp/Set requires no special installation, and it can be located anywhere in the composing room. It operates on ordinary house current from a standard wall outlet.

The Bunker-Ramo 230 Comp/Set computer is similar in its construction to the Bunker-Ramo 130 and 133 military computers in wide use at military installations throughout the world for photo interpretation, navigation, control, and simulation applications.

Bunker-Ramo pioneered the field of computer control, and their computers have inherently high reliability because their design requires fewer parts than conventional computers. The company still leads world-wide in the number of control computer installations.

The Bunker-Ramo Corporation, a subsidiary of Martin-Marietta Corporation, specializes in the design, installation and servicing of electronic systems for on-line data processing and process control in industry, business, and government.

Manual on Management of Data Processing Center

Burroughs Corporation
Detroit, Michigan 48232

The computer industry's first comprehensive manual on how to organize and control a commercial data processing center has been published by Burroughs Corporation.

"The need for this book is clear," said V. J. Ford, Burroughs' manager of market development. "The service center industry is young, but growing at a spectacular rate, and

the many problems peculiar to a new industry have come sharply into focus."

The 200-page, copyrighted manual, called "Service Centers: Organization and Control," is a documentation of the principles and techniques necessary for successful operation of a service center. Most of these detailed steps are known in one place or another, and have been discovered in hit-or-miss fashion, but until now they have never been assembled in a logical pattern that will serve as an operational blueprint.

The Burroughs executive said service centers, organizations selling data processing services to the general public for profit, are facing what might be called a happy dilemma: they must know how to grow rapidly and absorb large volumes of new business while maintaining quality and profits.

"This dilemma is very real," he said. "Marketing of services is not the problem. Service centers today are riding the crest of a seller's market. Their problems involve meeting demand, not creating it."

More than 900 such businesses, excluding those run by equipment manufacturers, now have a combined yearly revenue of $500 million, a figure which is expected to reach $1 billion by 1970.

Burroughs recognized the fact that many existing service centers, and those not yet in existence, need formal methods of control, but haven't the time or dollars to invest in the painstaking research needed. We thought it was time that the research be done and documented in a manual that would help establish sound organization and operation procedures.

"We have personal motives, of course," Ford said. "A great number of these centers use Burroughs data processing equipment and we want to help them succeed. However, the need in the industry for such a manual is so clear that we have decided to offer it to anyone who desires it, at the nominal cost of $15.00."

The Burroughs manual makes a detailed analysis of organization, operations, quality control, price estimating, internal controls, and personnel development, and offers dozens of exhibits illustrating work flow and control forms.

The manual does not attempt to present information on application problems such as how to set up a payroll for a customer, or how to control inventory. Instead, it concentrates on the "blocking and tackling" fundamentals of data processing as a business.

On the surface, the demand for service seems to be a tailor-made opportunity for the booming service center business. But, in order to take advantage of this potential, service centers must reckon with several formidable internal requirements. Most important among these are the need for well-trained personnel, good equipment, efficient computer programs, and profitable operating methods.

First, there is a definite shortage of highly trained personnel, especially programmers, with little immediate prospect for improvement in the situation. Service centers must be able to demonstrate that they have highly-qualified personnel in adequate numbers. The electronic equipment which the center uses can be obtained by any business with the necessary resources, but it is not easy to hire first-rate personnel to program and operate that equipment.

The industry has some advantage in attracting top notch people, because data processing personnel are direct labor in the service center, not overhead; this can mean higher status for those engaged in this work. Service centers, both individually and as a group, must exploit this advantage to the fullest in order to attract and keep high caliber people.

In addition, they should work through their professional organization to assist schools and colleges in establishing educational programs designed to produce the kind of specialists needed by their industry. How well the service center industry faces the critical problems of developing expert personnel, will, to a large degree, determine the scope of the industry's future development and growth.

Next there is the problem of choosing the right hardware. Equipment must be powerful enough to handle peak loads and still have a reserve capacity for emergencies. Equipment should have the capacity to expand as the business expands.

Equipment reliability can make the difference between the success or failure of a service center. Customers want speed, accuracy, and on-time performance. They pay for it. They have a right to be unsympathetic when told that a critical report was a day late due to an equipment failure. The finest DP personnel in the country can be handcuffed by inefficient or unreliable equipment. For the service center, maximum equipment 'throughput' spells profit.

Finally, there is the problem of achieving more profitable operating techniques. This is the important area covered by the Burroughs manual. Success at this level is critical to the overall profitability of a service center.

Growth through new business can actually be self-defeating for a service center unless the basic problems of operation have been solved. Burroughs believes the manual offers invaluable aid in solving these problems.

Management Operation Study

Carnegie Institute of Technology
Pittsburgh, Pennsylvania

A $400,000 Ford Foundation grant has been received by the Graduate School of Industrial Administration (GSIA) at Carnegie Tech for a 5-year study of management operations.

The project will be divided into three phases for study: management information systems, research-development, and marketing, according to Richard M. Cyert, dean of GSIA. Faculty members specializing in these areas will take part in the program.

"We will be dealing with the problem of how to bring about change and how to manage it once it has been accomplished," Dean Cyert said.

"Our project will encompass the entire picture of decision-making in business and the new concepts involving management practices. GSIA is particularly geared to handle this study since it pioneered in research that has revolutionized management practices and expanded basic knowledge of management processes," he added.

In the field of management information systems, Professor Charles Kriebel is already at work on a similar project for the Navy. The study will involve the use of computers for the storage and use of information necessary in decision-making.

"All the major firms will be engaged in this kind of activity within the next 5 years," Cyert predicted. He pointed out that two major industrial firms, Westinghouse Electric and the United States Steel Corp., are in the forefront of companies showing early concern for the development of management information systems.

"There is a tremendous waste of time and money in the paper work now required to gather information necessary to determine what course a company will take," the dean said.

The problems faced by firms in the field of research and development, and in particular the question of how to get creative people to do research and how to steer that research into channels best used by management, will be dealt with by Professor Igor H. Ansoff, a former vice-president and general manager of the Lockheed Electronics Co., and Professor Richard G. Brandenburg, assistant dean.

Problems faced in marketing products will be investigated by Professors Alfred A. Kuehn and John U. Farley.

The project will be closely linked with the Center for the Study of Information Processing, which has been established at Tech.

Remote Computer Medical Research

Case Institute of Technology
Cleveland 6, Ohio

Computer science has taken another step toward that often promised, but never realized, goal of the "central computer station," in which remote subscribers can have instantaneous access to the full capability of a large, ultra-fast computer.

In a joint announcement yesterday in Cleveland, Case Institute of Technology, the UNIVAC Division of Sperry Rand Corporation, and Western Reserve University Associated Hospitals revealed that a "satellite" system has been in operation since March 1964, directly linking a research project at Highland View Hospital with the giant UNIVAC 1107 computer at Case's Andrew R. Jennings Computing Center.

The distance is only 10 miles, but the system would work just as well if it were 100 or 1000 miles, for the linkage is an ordinary telephone line.

By means of the new system, the time required to evaluate the heavy load of experimental data has been reduced from 2 weeks to 1 day, and the actual computation time is often measured in seconds.

The announcement heralds a breakthrough in the use of computers in medical research. "Many research problems in medicine and biology have been beyond the reach of most laboratories," said T. Keith Glennan, President of Case, "because there was no way to process the vast amounts of data fast enough to make them useful in going experiments. In this current research at Highland View, each patient generates some 10,000 items of data each week. Only a large, extremely fast computer can handle such a work load, and very few laboratories for medical research can afford them. The only solution has been to transport the data physically to the nearest computer; this has proved to be an awkward and time-consuming arrangement.

"Now, with this system which gives a remote user access to the full capability of a large computer, a researcher even in a small laboratory can be as near as a telephone line to a computing center, and heavy loads of complex data can be processed almost instantaneously."

The announcement of the new system follows the disclosure earlier this year by Computer Sciences Corporation of two commercial and engineering applications, one involving the Signal Oil and Gas Company and the other, the Rohr Corporation, using similar equipment and programming techniques. The developments at Case and Computer Sciences Corporation, although virtually simultaneous, were carried out independently, and make it clear that remote, on-line computing for a wide variety of users is now a practical reality.

The three systems now in use are built around a UNIVAC 1004 card processor, interconnected by telephone line to a UNIVAC 1107 thin-film memory computer.

Since the Case-Highland View hookup has been in operation, research management at the hospital has received daily a complete statistical evaluation of the experiments in progress. So rapid is the system that an unsuccessful experiment can be redesigned or terminated while it is still in its early stages.

Commenting on the significance of the new system, Ray W. Retterer, Vice-President of UNIVAC, said: "There are many installations now in use in which a remote station can 'talk' to a distant computer, but until this new system was developed the remote station was limited to simple message switching or information retrieval. Now the remote station can analyze large volumes of information within the central computer, and use its full capabilities to handle complex problems of computation."

Literally thousands of potential users have needed the part-time services of a large-scale computer, but there has been no practical way of getting large quantities of data directly into and out of the computer at a distance without serious time losses. Now that this communication and programming problem has been solved, the way is open for any company, institution or agency to make full use of machine computation.

The original research project at Highland View Hospital was the out-growth of collaboration between the Hospital and medical engineers from Case's Engineering Design Center. Seeking a fuller understanding of human metabolism, researchers were faced by the need to record and analyze reactions of the patients to a wide variety of environmental variables.

Quadriplegic patients were chosen as subjects for the experiments because their almost total paralysis allows detailed observations to be made which would be difficult or impossible with patients capable of normal activity. They participate voluntarily and with complete cooperation even though the routines are vigorous, and do not always conform to standard patterns. The patients feel that their contributions to basic research will ultimately result in better understanding of their condition, leading to better care not only for themselves, but for others with similar problems.

Environmental variables include such factors as diet, feeding time, and turning time in bed. Biochemical variables include urine analysis by volume and specific gravity, and the amount of chloride, potassium, sodium, creatinine, total nitrogen, total solids, and aldesterone and other adrenal cortico steroids. Physiological variables include peripheral temperatures, abdomen and bladder temperatures, pulse rate, spasms, patient position, and insensible water loss. Room temperature and humidity measurements are also recorded.

Funds for this experiment in Highland View were provided by the Vocational Rehabilitation Administration of the Department of Health, Education, and Welfare.

Before the project was approached from a medical engineering standpoint it took the Metabolism Ward at Highland View as long as 6 months to obtain and evaluate such data in a single experiment. The Highland View staff first developed a series of auto-analyzers to record the data from each patient automatically. This reduced the time factor from 6 months to 2 weeks. Next, a new digital acquisition system was developed by the medical engineers which reduced the time from 2 weeks to 1 day. Finally, the computer installation was developed, and made it possible to evaluate a day's data in as little as 15 seconds.

Now that the complete system is in operation, all physiological data are automatically recorded from the patient and fed serially by channels into an analog recorder, which is operated in parallel with a digital recorder and a standard keypunch.

The digital recorder scans both the analog recorder and the auto-analyzers in the biochemical laboratory and automatically punches physiological and biochemical data into cards on the keypunch. The only data which is manually measured and keypunched is the specific gravity of urine and its aldesterone and other adrenal cortico-steroid content.

Punched cards are collected and manually entered into the UNIVAC 1004 card processor on a daily basis. This manual step is purposely included because punch card records of data simplify location, and errors can be easily corrected. Where desirable, however, the data can be transmitted directly to the 1004.

The 1004 then transmits the data by means of the telephone line. Telephone transmission is made possible by a UNIVAC data line terminal installed in the card processor. This equipment connects to a Bell Telephone data set which feeds experimental information through the phone line at the rate of 2400 "bits" per second or sixty-six 80-column cards per minute. At the Case Computing Center the data is received by another Bell data set, fed into a data communications terminal, and then into the computer.

The controlling factor in transmission speed is the phone line, since the 1004 processor normally operates at a rate of 300 cards per minute. The same is true for transmitting data from the computer to the hospital for printout on the 1004. Printout on the 1004 is at the rate of sixty 132-character lines per minute, although the normal printout rate of the 1004 is 300 lines per minute.

The tie-in with the large computer would be valueless, of course, if the communication system were not dependable. For this reason the new technique enables the operator to instruct the 1107 to guard against extraneous "noise" or errors in the system. If a transmission comes through that is not "rational" according to the original instructions, the 1107 instructs the 1004 to keep sending the specific block of data until clear transmission is obtained.

The new technique also solves a troublesome economic problem. Operating time on a computer the size of the 1107 comes high, but its speed is so great that actual working time is comparatively cheap. The trick is to "hire" the computer only for the time it is actually needed, sometimes only a matter of seconds or minutes. To achieve this goal, the 1107 is instructed to store the incoming data from the 1004 until all of the items in a particular transmission have been received. Then, and only then, the 1107 goes to work and—literally at lightning speed—performs the computations.

Active in the development of the new system at Case were Professors George Hayman and William Lynch of the Computing Center, aided by their students, and Al Misek, Chief Engineer.

The Highland View study is under the direction of Dr. Olgierd Lindan, Director of the Metabolic Ward, assisted by Dr. Robert Greenway, and Case graduate students Paul King, William Baker, Jr., Howard Apple, and Charles Kramer.

Biomedical engineers from Case are under the direction of Professor James B. Reswick, Director of the Engineering Design Center.

The UNIVAC 1107 is one interesting member of the new family of transistorized computers. It was the first to employ a thin magnetic film control memory, and can "read out" information in 600 billionths of a second. In addition, it employs a core memory with a storage capacity of 65,000 words, and a drum memory with a capacity of 746,432 words. It was purchased with the aid of $500,000 grant from the National Science Foundation.

Now that a customer with a small "satellite" computer can have access to the full capability of a large computer located many miles away, and handle large quantities of complex data, a wide range of possibilities is opening up for business and industry. In addition to the two similar systems developed by Computer

Sciences Corporation which were mentioned earlier, Case is now developing a satellite system linking Lord Manufacturing Company in Erie, Pennsylvania, with Case's UNIVAC 1107 in Cleveland.

As in the Highland View hookup, the new system will enable Lord to handle large volumes of data via telephone lines. It will handle computations for research projects in a wide variety of areas, ranging from investigations of the structure of materials to studies of vibration and dynamic disturbances encountered in outer space.

The "satellite" idea may have unexpected applications on the Case campus, too. A system is being studied which would link the UNIVAC 1107 to input-readout stations in the new undergraduate residences now being built adjacent to the main campus. These remote stations would enable students to use one of the biggest, most expensive, most sophisticated computers in the world to help them with their homework!

Study of Computer Potential in Helping Pupils Learn

Florida State University
Tallahassee, Florida

An experimental program to examine the potential of the electronic computer in meeting the individual learning needs of students, from kindergarten through graduate school, has been launched at Florida State University. The project is being undertaken by FSU with the cooperation of the Florida State Department of Education and International Business Machines Corporation.

The research effort uses a typewriter-like keyboard terminal linked by telephone wire to an IBM computer system some 1200 miles away at the company's Thomas J. Watson Research Center in Yorktown Heights, New York.

FSU's experiment will utilize computer assisted instruction, a system developed by IBM which enables an educator to enter instructional material, questions, and guidance into a computer for presentation to students on typewriter consoles or other equipment. The course unfolds at a pace and in a manner determined by a student's demonstrated ability.

Instructional material used in the computer project is organized, edited and sequenced by the actual teachers of the courses, who are doubly qualified in knowing both their subject matter and the ways in which students learn. The responses made by each student on the typewriter terminal are compared by the computer with the correct answers stored in its memory. This, together with the fact that the computer also keeps stored a record of each student's performance, enables the presentation of the material to be tailored to the individual's capacities.

Here is how the system works: The student receiving computer assisted instruction goes to the terminal in accordance with his schedule. There, he types his name, student number and the course title. The computer automatically checks this data to verify how far the student has progressed in the course, and then presents the next lesson.

This usually takes the form of text which the student studies, either for as long as he wishes or for a predetermined time. The typewriter terminal next prints out questions under computer control.

If a student responds correctly on the keyboard of the terminal, the computer will - in a typical course - then present another portion of the lesson for study. For incorrect answers, however, the course author will have previously entered other information into the computer which is presented to the less proficient student. This can take the form of additional remedial reading plus alternative questions which guide the student at a slower pace toward an understanding of the material.

In addition to testing the potential value of computer assisted instruction, the project will furnish University faculty members with specific data on student learning processes. This information will enable educators to investigate the characteristics of individual instruction and its best use by the classroom teacher.

The study will also serve to measure student acceptance of the computer as an instructional aid, and its relation to other instructional

techniques. The FSU educators are also seeking to discover any differences in the effectiveness of the computer technique at all grade levels, from reading readiness in kindergarten to course work for graduate degrees.

Subject matter now being developed and tested includes solution of trigonometric identities, educational measurement, non-metric geometry, learning paired associates, test validity and stress and strain tensions.

Dr. Donald L. Hartford of the FSU School of Education's Department of Research and Testing, and the Institute of Human Learning, will supervise FSU's participation in the project. According to Dr. Hartford, there is widespread interest in the project throughout the University. Many faculty members plan to investigate the implications of this program for their fields.

Dr. Hazen A. Curtis, head of the Educational Research and Testing Department, has stated that the large memory capacity of the computer will allow the classroom teacher to follow the learning process of the individual student better than has been possible in the past. With a deeper understanding of these individual needs, Dr. Curtis feels that a closer relationship can be established between the student and the teacher.

Dr. Edward Adams, Research Director of IBM's computer assisted instruction effort, said that as important as the computer and its terminal are in the program, they are overshadowed by the role of the teacher responsible for developing the course material. IBM has therefore concentrated, he said, on developing techniques which allow educators to prepare course material for the program, even though they are unfamiliar with computers.

Work in computer assisted instruction at IBM's Research Division is part of the activity of the IBM Instructional Systems Development under Charles E. Branscomb. This department plans to work with universities and other educational institutions as they develop teaching techniques which use machine systems. It will also continue an intensive program within IBM to increase the capabilities of the systems themselves.

DAC-I Project

General Motors Research Laboratories
Detroit, Michigan 48202

An experimental computer facility that may someday be used by General Motors engineers to help create new automotive designs was described at the Fall Joint Computer Conference of the American Federation of Information Processing Societies.

The laboratory for design research is part of the General Motors DAC-I project (Design Augmented by Computers), a system under development during the past several years by GM's Research Laboratories.

The prototype man-machine design system has been operating for experimental purposes for 8 hours a day since early 1963. In its present form, the DAC-I system consists of a large scale computer, a man-computer communication console, and image processing equipment which enables the computer to read and generate drawings. In addition, the GM researchers have developed a large library of computer programs (more than three-fourths of a million instructions) to enable the designer to use his equipment effectively.

Such a combination makes possible experiments in "conversational communication" between designer and computer. The "conversation" is in engineering graphics—the drawing language used by draftsmen and designers to convert their design ideas into final products. Participating in these experimental applications are design groups from GM's Fisher Body Division and Styling Staff.

The DAC-I laboratory facilities were described in four technical presentations at the computer conference by members of General Motors Research Laboratories' Computer Technology Department. A fifth paper was presented jointly by GM researchers and members of International Business Machines Corporation's Data Systems Division. The special

image processing equipment used in DAC-I was designed and built by IBM to General Motors' specifications.

The General Motors computer researchers explained that the system thus far has achieved three major goals heretofore not attained in a single computer system:

1. The computer can now "read" key lines from engineering drawings and store the information in its memory storage units.

2. The designer and computer now have direct methods of rapidly communicating graphic information back and forth as the man employs the computer to develop or to modify a design.

3. The computer can generate permanent drawings on 35 mm film which can, in 30 seconds, be developed and ready to be enlarged into working drawings. For finished engineering drawings, the computer can produce tapes that control drafting machines.

These three goals, they said, were achieved through several major advances in computer technology, involving both new computer hardware and new computer software (i.e., special instructions programmed for the computer).

One of the new hardware units is a graphic display console at which the designer observes the computer's handling of his design problem on a TV-type viewing screen. When needed, he may modify his design or give the computer further instructions using such options as an electric "pencil," a typewriter-like keyboard, a data card reader, or 36 program control keys.

The other hardware unit is an image processor used for input and output of drawings. Key lines on 20-by-20 inch paper are entered into the image processor. After being photographed on film, the line can be optically scanned by a cathode ray tube that is under the control of computer programs. Conversely, the image processor can produce an output drawing ready for viewing in 30 seconds after a request is made of the computer.

The General Motors computer people reported that one of the key software features of the DAC-I system was a successful "multiprogramming" monitor. The monitor allows the computer to spend any available time, down to a thousandth of a second, solving other engineering problems whenever the man at the design console is thinking or putting in new information. This efficient use of costly computer time is one of the essentials to economic application of man-computer design teams.

HISTORICAL BACKGROUND OF DAC-I PROJECT

The general field of mechanical design has for years depended on the techniques of drafting as a means of design prior to the making of models. Graphics, the art of science of drawing, serve as the basic means of man-to-man transmittal of design information.

In the late 1950's the General Motors Research Laboratories began a study of the potential role of computers in the graphical phases of design. Prototype hardware and software components were developed to investigate the problems of processing graphical data. For example, a breadboard setup using an IBM 740 cathode ray tube recorder demonstrated that lines on film could be scanned and digitized under the control of computer programs. Programs were written for the manipulation of images in three dimensions.

GOAL OF DAC-I PROJECT ACHIEVED IN 1963

As reported to the 1964 Fall Joint Computer Conference by Edwin L. Jacks, assistant head of the GM Research Laboratories' Computer Technological Department:

"On the basis of these early feasibility demonstrations, the decision was made to establish a more comprehensive laboratory for graphical man-machine communication experiments. The facilities were to permit the computational power of a large scale digital computer to be brought to bear on the problems of graphical design in a manner which fully recognized the importance of the man in design. The project has since become known as Design Augmented by Computers.

"The initial goal of the DAC-I project was the development of a combination of computer hardware and software which (a) would permit 'conversational' man-machine graphical communication and (b) would provide a maximum programming flexibility and ease of use for experimentation. This goal was achieved in early 1963."

The DAC-I system has been in operation 8 hours per day since then. Mr. Jacks reports: "From the standpoint of a laboratory facility, the system is performing excellently. We are

learning that man and machine can communicate readily via graphical means."

DAC-I HARDWARE

The present DAC-I hardware complex consists of an IBM 7094 digital computer and an IBM 7960 special image processing system.

The 7094 computer has an extra-large 64K core memory unit, half of which is available for multiprogrammed use on DAC-I problems. In addition the computer has extended storage facilities: two 55-million character 1301 disk files and three 1-million character 7320 drum units.

The 7960 special image processing system was developed and built by IBM's Data Systems Division to specifications provided by the General Motors Research Laboratories. The specifications were based upon early GM experiments with computer displays, recording devices, and program-controlled image scanners. Its two main units are:

1. A graphic console which provides for a dynamic two-way communication between the designer and the computer. The console is equipped with:

(a) A cathode-ray-tube (CRT) display screen

(b) An electric position-indicating pencil, used by the man to respond to the computer by pointing to an area of interest on the display.

(c) Thirty-six program control keys and program status lights. The man at the console can monitor the status lights and control the program execution with the keys.

(d) Two data entry devices. One is an alphanumeric keyboard for "typing" messages into the computer. The other is a card reader with which the man enters data and "sign-on" identification.

2. An image processor used for the input and output of graphical data.

(a) Input operation. A sliding drawer allows the designer to enter key lines drawn on 20 by 20-inch paper or vellum. A camera translates the image to 35 mm film which is developed in 30 seconds. A GM-developed computer program then controls the positioning of a CRT beam optically focused on the 35 mm image. A photomultiplier response back to the computer indicates if the beam is on clear or opaque portions of the image. The program searches for opaque lines on a clear background. In its present state of development, the scanner can detect and digitize lines as thin as 0.01 inch with an average accuracy of plus or minus 0.015 inch. The line scanning is controlled from the console and in areas of difficulty, e.g., a finger smudge, the man can help guide the computer past the difficulty using the electric pencil and a TV sweep display of the localized area.

(b) Output operation. A second high-resolution CRT is used as a recorder for exposing frames on either of two 35-mm film transports. The film is automatically developed and ready for viewing on a 20 by 20 inch screen within 30 seconds after exposure. Drawings from both film trains can be projected simultaneously on the screen, allowing the designer to compare differences and similarities in the information. A film buffer allows up to 20 images to be exposed before processing begins.

DAC-I SOFTWARE

The computer instructions, or software, which operate the computer complex are all new and give DAC-I its unique design capabilities. It is the exclusive development of the GM Research Laboratories' Computer Technology Department. Among the advanced software techniques incorporated in the DAC-I system are four major departures from conventional programming techniques:

1. Multiprogramming monitor. Allows the computer to be working concurrently on two different problems. It thus permits a designer to be working "on line" with the computer efficiency.

2. New compiler language, NOMAD. Ninety percent of the DAC-I software system was written in a very flexible and fast compiler called NOMAD, a GM Research revision and extension of the University of Michigan's MAD system (Michigan Algorithm Decoder).

3. Program storage allocation control. Permits the computer program to make "at the moment" decisions on efficient allocation of core memory to meet the changing data and program demands of the problem being solved.

4. Disk-oriented system for storage and retrieval of programs. Allows access within a fraction of a second to millions of words of program and data. System is so arranged as to

permit continued growth of DAC support programs with no change to control programs.

In addition special software has been devised for programming the graphical input/output hardware.

"SPLIT-MEMORY" MULTI-PROGRAMMING

The DAC-I laboratory requires that a large-scale computer be available, ready to respond quickly to the communication and computational needs of the man at the graphic console. To meet this requirement and still make economical use of computer time, the GMR Computer Technology Department developed a so-called "split-memory" multiprogramming monitor.

One-half of the computer's 64K memory contains the normal GM engineering or research job being processed by a batch processing monitor. In the other 32K resides the DAC-I problems and data being worked on by the man at the on-line console. The GM multiprogramming monitor switches control to DAC-I (within 50 microseconds) as demanded by the man or DAC-I hardware. These random instantaneous demands may come as often as 400 times in 1 minute. In total, however, for every hour at the console the designer requires only about 8 minutes of computer time for his work. The GM multiprogramming monitor makes it possible for this large percentage of available time, down to a spare thousandth of a second, to be used by the computer on normal jobs.

In summary, the GMR multiprogramming monitor features:

- Highly efficient time-sharing of the computer's central processing unit;

- Minimum cross-over errors between programs because of an effective core-memory protection system; and

- Complete accounting of multiprogrammed computer time using a special "millisecond interval" clock built by GM's Delco Radio Division.

NEW COMPILER LANGUAGES

To handle the immense programming support for the DAC-I system, GM Research Laboratories' computer programmers developed and used a very fast and flexible compiler language called NOMAD. NOMAD is a higher level language similar to FORTRAN and ALGOL. Basically, it is an extension and revision of the University of Michigan MAD language. (Michigan Algorithmic Decoder is in the ALGOL '58 family of languages.) The NOMAD dialect differs from MAD in four areas: (1) additional operators; (2) new variable types; (3) new relocation scheme; and (4) real-time statements.

Among other things, these extensive revisions represent steps toward a language which recognizes parallel processing in a large computer, an area where computer software has been lagging behind hardware.

In an unusual programming twist, the NOMAD compiler was also used to write another GMR compiler called MAYBE. Used by systems programmers, MAYBE provides instructions and commands for operation of the data channel which connects the computer's central processing unit with the DAC-I input/output devices.

DISK-ORIENTED OPERATIONAL SOFTWARE

In another departure from conventional programming, GM Research programmers have provided in the DAC-I system for a disk library of programs available during program execution. From the point of view of the man at the DAC-I console, this disk-oriented software allows him to: (1) introduce data rapidly and accurately to the computer; (2) perform various operations on this data; (3) observe the results of these operations and modify them while still on-line; and (4) file the original data and final results for future references.

In their paper before the 1964 Fall Joint Computer Conference, GM Research computers programmers Phyllis Cole, Philip Dorn, and Richard Lewis conclude:

> "Our experience indicates it is feasible to operate from a disk and gain rapid access to large amounts of information, thus attaining considerable on-line capability. To obtain this on-line capability, users must pay a penalty in several areas. Core memory space must be reserved for an in-memory loading and relocation routine. Machine time must be granted for disk bookeeping and editing functions. Compatibility with other installations is completely lost.
>
> "In return for this investment, the system allows access to an enormous library of

routines without having to deal with an object level card deck. Large quantities of data are stored on-line and may be added to, modified, deleted, or used with no difficulty. Both subroutines and data are always available; run preparation time is sharply reduced."

STORAGE ALLOCATION CONTROL BY SOURCE PROGRAM

One special feature of DAC-I's disk-oriented system is storage allocation control by the source program. Programs can make decisions at execute time on allocation of space in the computer's core memory: some portion for data, the other portion for needed subroutines. Instead of the usual prefixed space commitments, this GM-developed control allows each program to adjust storage assignment dynamically as a function of data needs. It is another way that GM programmers have provided for the changing needs of the designer at the console.

SPECIAL I/O SOFTWARE FOR PROGRAMMERS

Computer programmers at the GM Research Laboratories also developed flexible and easy-to-use software to enable them to use fully the man-machine communication capabilities of the DAC-I hardware (i.e., the on-line console and image processing equipment). For example, with a minimum of fuss and bother the programmer may use the console's cathode ray tube for the output of either alphanumeric information or requests for operator action. Or he may use the voltage pencil for the input of positional information, the keyboard for input of alphanumeric information, and the program control keys for the input of decision information. Providing these input/output capabilities are a set of subroutines and source language statements that are conveniently referenced in the NOMAD language. The advantage of such general purpose software? As GM Research computer programmers Thomas R. Allen and James E. Foote state in their 1964 Fall Joint Computer Conference paper:

"By providing an extensive, flexible, and powerful I/O software capability, the presence of the hardware interface need not concern the programmer and he can devote his whole attention to the more significant aspects of man-machine communication."

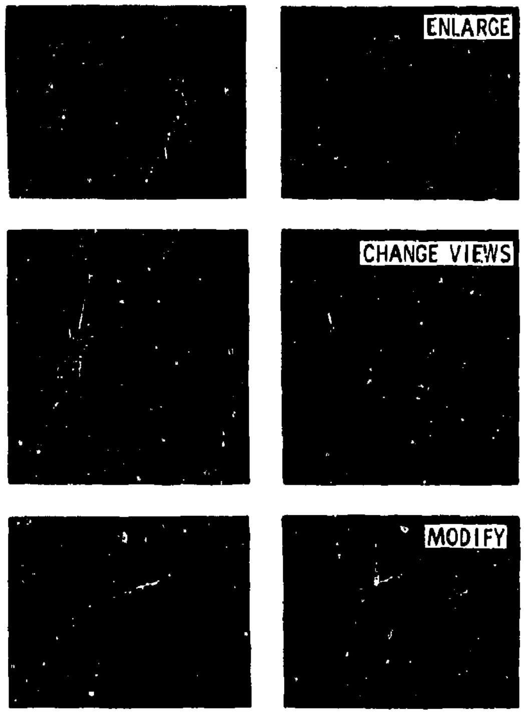


Figure 1.--A new angle to car design--These "before" and "after" displays were generated by a digital computer under instructions from a General Motors designer. They illustrate three of the capabilities of DAC-I (Design Augmented by Computers), an experimental man-computer design system developed by General Motors Research Laboratories.

The drawings appear on the viewing screen of the designer's console and come from a mathematical representation of the design stored in the computer's memory. In one case, MODIFY, the DAC-I system has enabled the designer to make a major revision in the deck lid of a car while working at his console and to see immediately the results of his changes.

Document Retrieval Systems Testing

Herner and Company
Washington, D.C.

Herner and Company has formed an evaluation section to undertake tests of the effectiveness of document retrieval systems utilizing techniques of the type developed in England by Cyril Cleverdon.

Test programs are carried out under the immediate supervision of F. W. Lancaster, former member of Cleverdon's Cranfield team.

Any type of document retrieval system can be tested with techniques which involve measurement of response to a number of "synthetic" and "real-life" questions.

System effectiveness is measured in terms of the percentage of known relevant documents in the collection retrieved in searching, and the percentage of total search output judged relevant by the original questioner.

Test programs are designed to permit analysis which can identify defects and sources of failure, as well as indicating system efficiency. A detailed report summarizing findings on system behavior, drawing useful comparisons with other systems, and making recommendations on means of improving the system or its operation, is the final product of a Herner test program.

Test programs have already been completed for a number of organizations, the most recent being the U.S. Navy Bureau of Ships Technical Library.

PLATO II and III

Coordinated Science Laboratory
The University of Illinois
Urbana, Illinois

INTRODUCTION

The purpose of the PLATO project (see Digital Computer Newsletters dated Oct. 1961, July 1962, Apr., July, Oct. 1964, and Jan. 1965) has been to develop an automatic computer-controlled teaching system of sufficient flexibility to permit experimental evaluation of a large variety of ideas in automatic instruction including simultaneous tutoring of a large number of students in a variety of subjects. The PLATO system differs from most teaching systems in that the power of a large digital computer is available to teach each student since one such computer controls all student stations. The project work has fallen into three categories, no two of which are wholly separate from each other: (1) development of the tools for research; (2) learning and teaching research; and (3) provision of a prototype for multi-student teaching machines.

PLATO III SYSTEM EQUIPMENT (PLATO HARDWARE)

During the third quarter of 1964, work continued on the development and construction of circuitry required for the realization of a 20-student station teaching system.

Student station circuitry constructed through August 1964, to date included all circuitry required for the operation of two student stations. A continuing exemplary effort by various technical sections of the laboratory dealing with circuit packaging and fabrication suggested that at least a total of 10 student stations were to be operable by some time in November 1964.

The interface circuitry was expanded to include the CSL CSX-1 computer as an alternative computer facility to the CDC 1604. Checkout of the interface was facilitated by a compact general engineering routine written during the third quarter of 1964 by Mr. G. Frampton.

Development continued on special circuitry which would update the then present circuitry or provide special system facilities. Included in the special circuitry was transistor deflection, power control, master keyset, and master video switch circuitry.

PLATO III COMPUTER PROGRAMMING (PLATO SOFTWARE)

The Resident Program for CATO (CATORES)

CATORES has been functional for some time as an input-output monitor for machine language teaching programs communicating with the PLATO III equipment. During the third quarter

of 1964, the program underwent a careful examination and re-evaluation with respect to efficient use of the PLATO III equipment, with respect to features suggested by the users as desirable, and with respect to ultimate compatibility with CATO-compiled programs. As a result, the program was almost completely rewritten, with many additions and extensions.

Three different methods of recording student data on magnetic tape were available by August 1964. For code-checking, student data could be output to the printer or to the typewriter as each key was pushed. Elaborate checks were established to avoid unnecessary, time-consuming storage tube operations for a student. The plot and selective erase routines were expanded and genralized for easy use with CATO-compiled programs, and several subroutines were added expressly for use by CATO programs. In addition, the addresses of the subroutine entries and the structures of several internal lists were modified to meet restrictions imposed by CATO.

Finally, three manually-entered routines were added. PROGSAVE allows an entire teaching program to be written on an auto-loadable magnetic tape. SPECTRE allows a student's actions to be played back in real time, half time, or double time by executing data read from the student data tape. RESTART allows a program to be continued from the same point at which it was stopped (in case a lesson runs more than 1 day, or in case of equipment failure). The program uses the data on the data tape to reproduce the exact situation present in memory and on all student screens at the time stoppage occurred.

A comprehensive machine language engineering program was also written in conjunction with the revision of CATORES. This program was used extensively to check and to evaluate the changes to CATORES as they were made and is now used to facilitate the maintenance of the PLATO III equipment.

DOPEREA

PLATO "dope" is defined as the record of a student's operation of a PLATO keyset. The number of each key pushed is stored on magnetic tape along with its associated time, mode, and student number. The stored records may be analyzed at a later date in any appropriate fashion. A machine language FORTRAN subroutine, DOPEREA, was written which reads and translates the PLATO "dope" tapes to binary numbers fast enough to allow smooth reading.

The CATO (Computer for Automatic Teaching Operations) System

CATO (Compiler for Automatic Teaching Operations) was completed during the third quarter of 1964. The system contains three major portions:

FORTBIN—An expanded and modified version of the FORTRAN-60 algebraic compiler for the 1604.

LOGICOMP—A logical compiler which constructs a teaching logic interpretable by CATORES from a vocabulary of 10 directives.

SYSTEMS TAPE—a set of modified subroutines and programs to allow easy use and modification of the system and all programs compiled with it.

PLASMA DISCHARGE DISPLAY TUBE RESEARCH

The purpose of the research on the plasma discharge display tube is to develop a less expensive replacement for the present PLATO storage tube system. The feasibility of initiating the discharges from outside the tube was tried with excellent success. Controlling the discharge from outside the gas environment not only simplifies construction by allowing the electrodes to be in the external environment, but also effectively adds series impedance to each bulb which helps isolate each cell from its neighbors. The freedom from adjacency initiated firing was to be investigated during the fourth quarter 1964, since the firing of adjacent cells should no longer be a problem.

The cell which was used to demonstrate the feasibility of externally controlled discharges was constructed in the following manner. Three glass cover plates 25-mm square by 0.15-mm thick were prepared for use in a vacuum system. On two of these a gold strip 25 mm by 0.127 mm by 100 Å was deposited on the side that was to be on the outside of the cell. The third slide had a 0.127-mm hole drilled in its center. A 0.05-mm thick mylar spacer to channel gas into the cell was placed on either side of the plate with the hole (cell) and the other plates on either side with the gold contacts outwards. The whole assembly was connected to glass tubing with epoxy and filled with neon.

PLATO LEARNING AND TEACHING RESEARCH

Inquiry Training (REPLAB)

A 4-week workshop was conducted in June in the College of Education of the University of

Illinois to instruct 28 elementary teachers in the use of scientific inquiry classroom techniques. A demonstration class of 22 pupils drawn from the local community was held in conjunction with the workshops. The pupils used the PLATO program, REPLAB (described in an earlier progress report), as one of the lessons in inquiry. The lesson is based on a bimetal strip experiment. No statistical analysis was made of the work of the summer students. For comparison with classroom behavior many of the workshop teachers monitored the students while they were using PLATO, watched reruns of student performance, or received copies of the "dope" sheets (student records). Interested teachers were also permitted to try the lessons themselves. The rerun of student performance was made possible by a computer program, SPECTRE, which simulates students using PLATO by reconstruction of the operation from the "dope" record stored on magnetic tape during a PLATO lesson.

Teaching A B C's

Four 3-year-old children spent two short sessions on PLATO using ALPHABAT, a program designed to teach the letters of the alphabet. The PLATO equipment was modified to include a semi-automatic audio system. The students were first shown a letter on the screen, told its name, and asked to match it. Later on, they were not shown the letter, but were simply asked to press the key named. The children's reactions and progress gave insight into methods of effective programming for, possible simplifications of, and additions to the PLATO system for use in primary and preprimary education.

Text Tester

A new program called Text Tester was developed during the quarter ending in August 1964. This program was designed to be used in testing new textbooks. The program provides for reproduction of text materials on slides with the insertion of student answers from the keyboard as in PLATO tutorial logics. The student is permitted wide freedom in the use of the text; therefore, he is allowed to turn pages and to answer questions at random. He is permitted, but not required, to check answers using a judger which compares students' answers to lists of stored correct answers. Provision is made for the insertion by students of paragraph-form comments about the text materials. Provisions for testing the student at various points throughout the text are also included.

A major feature of this program is the inclusion of "author modes" by which the author may insert or modify correct answers, and insert comments which are intended to help students at specific points in the program, or which are intended to elicit comments from the students.

Text Tester is the first program ready for use with the PLATO Compiler. Code-checking of the Text Tester program will be carried on in September followed by trials of the program with students later in the fall.

Proof

Work was continued during the third quarter on the preliminary programming and advanced planning of the program for the study of mathematical problem solving (first described in CSL Report R-185).

Experimental Computer-Assisted Instruction System

International Business Machines Corporation
Yorktown Heights, New York 10598

Scientists at the IBM Thomas J. Watson Research Center are experimenting with a computer system, which can simultaneously give individual instruction to a number of students in a wide variety of subjects. The Research Division's experimental system makes the capabilities of a computer system accessible for convenient use in experiments by educators. The system is based on standard IBM equipment, but incorporates an experimental computer language that makes it simple for educators to put courses into the computer.

The College of Education of The Pennsylvania State University, University Park, is undertaking an experimental study in cooperation with IBM to prepare instructional material for computer presentation and to study its effectiveness. Faculty members at Penn State are preparing four courses for use by students at a typewriter station located on campus. This station is connected via commercial telephone lines to an IBM data processing system at the Research Center in Yorktown, N. Y.

A variety of other experiments can now be undertaken to evaluate "computer assisted instruction," and to devise and test ways of using the approach to best advantage. IBM emphasized that the ultimate usefulness of computers

for instruction will not be known until extensive experiments have been conducted.

Such studies will enable educators to learn how different subjects can best be taught with the system, and how computer assisted instruction might be integrated into the overall educational process. An important feature of the Penn State studies is that each course author is both accomplished as a teacher and experienced in the subject matter to be taught.

In the experimental system, a teacher's instructions, questions and guidance are stored in the computer and presented to students on typewriter consoles or other student station equipment. Since the student's response, made on the typewriter, can be analyzed by the computer, presentation of subsequent course material can be tailored to the needs of each student.

At present, each student station consists of a typewriter console, through which the student receives directions from the system. The student's response on the typewriter can be many words in length. The computer analyzes the student's reply, and, according to the plan laid out by the teacher, responds with clues, questions, remedial study matter, drills, or the next assignment. The computer also can record response times, errors, and other data on the student's performance. Thus, an extensive analysis of both student performance and the adequacy of the course is possible, with the opportunity of improving each.

The extensive record-keeping capability of the computer system will also permit valuable research on teaching techniques and the learning process itself. Thus, apart from its usefulness as an instructional tool, computer-assisted instruction should lead to better understanding of the educational process.

The courses being prepared at Penn State are one-term, three-credit courses normally offered at the University. They include "cost accounting" and "engineering economics" for advanced business and engineering students, "new mathematics" for prospective elementary school teachers, and "audiology" for majors in special education. The Penn State project, which is under the direction of Professors Harold E. Mitzel and Kenneth H. Wodtke, is being aided by a grant of $97,000 from the U.S. Office of Education under the provisions of Title VII, Part B, of the National Defense Education Act.

Within IBM, a variety of courses, ranging from general education to training in specific skills, are being put on the computer to evaluate methods and techniques of computer instruction. IBM scientists feel that computer instruction holds special promise for adult education programs because it has potential for dealing with wide differences in educational background.

Dr. Edward N. Adams, IBM Research director of computer-assisted instruction, said that although the equipment itself is of great importance, the effectiveness of computer instruction will depend critically on the knowledge, understanding, and imagination of the teacher who writes the course material. For this reason, one of the chief aims of IBM researchers has been to make the writing of courses for the computer convenient, so that teachers can experiment with the concept, even though they may be completely unfamiliar with computers.

With the present experimental system, a teacher can simply type his course material, along with a few special symbols, at one of the typewriter stations. The computer then generates its own detailed instructions for handling each section of the course material.

Work in computer assisted instruction at IBM's Research Division is part of the activity of the IBM Instructional Systems Development Department under Charles E. Branscomb. This department plans to work with universities and other educational institutions as they develop teaching techniques which use machine systems. Also it will continue an intensive program within IBM to increase the capability of the systems themselves.

Pioneering studies in computer-assisted instruction at IBM Research were started in 1958 by Dr. Gustave J. Rath, Dr. Nancy S. Anderson, and Richard C. Brainerd. They investigated the use of a computer and a typewriter for instruction in binary arithmetic. In these preliminary studies, only one typewriter terminal was used, and instructions to the student were given orally by the instructor, rather than by the computer.

The present concept of computer assisted instruction evolved from a system developed by Dr. William R. Uttal in 1961. Experiments were performed with a modified IBM 650 computer and specially designed electrical equipment to connect the student stations to the computer.

Now two computer systems are being used in experimental studies in computer instruction. Each system consists of the following basic elements: (1) 1311 disk storage drives, which are used to store the contents of the course material, along with other bookkeeping information, (2) a

central processing unit, which acts as an intermediary between the course material stored in the disk files and the students, (3) a multiplexing unit, which directs the "traffic" of messages between the students and computer, and (4) IBM 1050 data communication systems, or typewriter terminals.

Using this equipment, IBM researchers have experimented with a number of teaching techniques, which take advantage of the high speed data processing capabilities of the computer.

An experimental course in elementary statistics, prepared by Ralph E. Grubb, is similar to a sophisticated version of the "scrambled textbook." In this course, however, instead of selecting a multiple-choice answer the student constructs the answer. The computer compares the constructed answer with anticipated responses stored in the machine to determine what action to take next. By using the computer in this way, a student can be branched to different remedial materials, depending upon his answer. In addition, his previous responses may be used to determine what material will be presented next.

In solving numerical problems in the statistics course, students took advantage of the high-speed computational abilities of the computer directly through the typewriter student station. They used the typewriter station to perform addition, subtraction, multiplication, division, squares, and square roots.

In another experiment, Dr. Werner J. Koppitz used a drill technique for teaching a beginning course in German. After the student completed a reading assignment, a series of translation exercises was presented on the typewriter, testing the student's knowledge of the new material. If the student made an error in translation, he was informed of his mistake and asked to try again. Although there was no limit to the number of trials a student could make, he could ask for the correct answer if he wished. The computer recorded his mistakes and later repeated the exercises which were not answered correctly. If the student missed too many exercises, the entire lesson was presented again later.

To investigate computer instruction for teaching manual skills, Mrs. Anna Maher and Dr. William R. Uttal prepared an experimental course in stenotype, which was designed to give a basic proficiency in stenotype keying. In this course, words or phrases to be transcribed and the corresponding correct key combinations were displayed on a screen. After the student depressed the correct keys, the next item was presented. As the student progressed the display of key combinations was gradually eliminated. The computer recorded errors and drilled the student in his areas of weakness until he showed acceptable proficiency.

A new technique, called partial answer processing, is being explored by Dr. H. William Morrison, Herbert Baskin, Mrs. L. D. Selfridge, and others in the research group to increase the effectiveness of computer instruction. The degree of accuracy of a student's partly correct answer can be evaluated by the computer by use of this approach. Based on this analysis, the system can type back the correct parts of the response, give other clues, present a simpler question, or carry out other remedial operations.

Under study is a technique to permit a student to query the computer for information he needs to complete a problem or exercise. This capability, now used in some information retrieval systems, would be especially valuable in subject areas where the instructor could not easily anticipate what clues or information the student might need to complete a problem.

EXAMPLE NO. 1

Typewritten record of a lesson in mathematics, using computer assisted instruction. This sample lesson shows how specific hints and guidance can be given to a student in response to an incorrect answer. The letters in the left-hand column indicate: computer typeout (C) and student's answer (S).

C WHAT IS 2^3?

S -1

C DO <u>NOT</u> SUBTRACT. $2^3 \neq (2-3)$ OR $(3-2)$. TRY $\overline{2^3}$ AGAIN.

S 2.3

C 2^3 IS <u>NOT</u> ANOTHER WAY OF WRITING 2.3. $\overline{^3 \text{ IS}}$ AN EXPONENT. TRY 2^3 AGAIN.

S 5

C DO <u>NOT</u> ADD THE BASE AND THE EXPONENT. $2^3 \neq 2+3$. TRY 2^3 AGAIN.

S 6

C DO <u>NOT</u> MULTIPLY THE BASE AND THE EXPONENT. $2^3 \neq 2 \cdot 3$. TRY 2^3 AGAIN.

S 8

C CORRECT

EXAMPLE NO. 2

Typewritten record of a sample lesson in German. The letters in the left-hand column indicate: computer typeout (C) and student's answer (S).

The lesson embodies a new technique being explored at IBM's Thomas J. Watson Research Center, in which the computer analyzes the student's answer and types back only correct portions of the answer. Missing or incorrect letters are indicated by hyphens for lower case letters and underline marks for upper case letters.

C	The ring is round.
S	Das ring is rund.
C	D-- _ing is- rund.
S	Der Ring ist rund.
C	Correct
C	The house has cold rooms.
S	Der Haus haben kalt Zimmer.
C	D-- Haus ha- kalt- Zimmer.
S	Das Haus hat kalte Zimmer.
C	Correct
C	Did you see the dog?
S	Haben sie sehen das hund?
C	Haben _ie d-- _und --sehen?
S	Haben Sie der Hund gesehen?
C	Haben Sie d-- Hund gesehen?
S	Haben Sie den Hund gesehen?
C	Correct

Management Data Processing

Jantzen, Inc.
Portland, Oregon

"Ours is a business of futures, but for years we've been running solely on information from the past. All this has changed now at Jantzen." With these words, Paul DeKoning, president and general manager of Jantzen, Inc., the world's largest and oldest manufacturer of sportswear and swimsuits, in November 1964, introduced and demonstrated Jantzen's completely operational computer-based management information system. The demonstration took place at the company's Portland, Oregon, world headquarters.

The new system represents the apparel industry's first application of data processing to all significant company operations including finance, merchandising, manufacturing, and marketing. It provides Jantzen management with a close look at what's happening minute by minute to a growing company in a fast changing market. This system was developed by Jantzen in cooperation with International Business Machines Corporation and is based on an IBM 1410 computer which is to be replaced in 1966 by an IBM System/360, Model 50.

Jantzen pioneered in the use of machine data processing systems with the installation, in 1929, of the first IBM machine in the pacific northwest. This 45-column, round-hole, mechanical sorter was just the beginning of many evolutionary changes which have led to Jantzen's present computer proficiency.

In 1959, after the company sensed a lengthy information time lapse and limited systems development, an IBM 650 RAMAC computer was installed as the initial step toward a total management information system.

Two years later an IBM 1401 computer with four tape drives was installed to replace the 650 RAMAC. The increased speed and capacity of this equipment permitted a greater degree of sophistication in computer applications.

During this period, Jantzen linked the 1401 tape system in Portland to a 1401 card system in Seneca, South Carolina. This teleprocessing system permits the fast interchange of current production and shipping information. Research during this same period led to a refinement in estimating and forecasting techniques.

In 1963 the programming and systems staff began defining and organizing the key operations they would perform on the 1410-1301 data processing system which was delivered in September. This third upgrading of Jantzen's computer power now makes it possible to convert to an electronic order allocation system. This machine conversion to order filling can be followed by a cost-saving pre-billing of customers' invoices.

Delivery of an IBM System/360 in the fall of 1966 will permit the complete consolidation of

vital management information. Transmission of data from a decentralized computer directly into home office facilities will be feasible and immediate access to stored information will be practical.

During the period of problem definition and systems development for the 1410 and System/360 computers, a specialized apparel industry "total information system" will be coming to full bloom at Jantzen. Applied during the early 60's, in a few other industries, the computer-based technique integrates all significant company operations into a group of interdependent applications to provide a basis for sophisticated decision making. It is new to the apparel industry.

Jantzen's system is designed to give vital information in four key areas of the company:

• Merchandising—the management information system is geared to give statistical information which defines characteristics of the volatile fashion market and indicates consumer preferences. Analytical research into historical buying patterns gives the merchandisers direction when relating style and color trends to seasons and geographic regions.

The projected acceptability of new lines which have just been launched can be forecast as soon as any significant orders have been processed. This acceptability can be defined by styles within lines, delivery and period requirements within seasons, and projected gross profit margins based on sales mix.

• Manufacturing—computer estimating and forecasting techniques translate the current customer orders into future demands. These figures are used as a basis for establishing the production programs and issuing material purchase orders.

Machine scheduling of production in company-owned plants will permit the optimum use of production facilities.

The use of variable delivery lead times in scheduling material needs will permit the most profitable raw inventory turn.

Machine preparation of factory work orders establishes data which can be used in many ways to measure factory progress and efficiency and to prepare piece-work payrolls.

• Marketing—sales goals and quotas serve as planning guidelines for several areas within the company. Marketing reports tied to these quotas give management an immediate measure of the sales production by salesman or sales region.

Order bookings are related to retail accounts to report "sold and unsold" customers and to measure current-season sales to past performance.

In order to measure the degree of sales saturation in a variety of markets, results are also compared to national apparel sales indices.

The obligation assumed with the booking of the order is not completed until the order is coordinated, completed and shipped on time.

Utilization of the computer to make the thousands of decisions necessary to match orders properly to inventory is mandatory in maximizing inventory turn and customer satisfaction.

In practice, the 1410 system permits next-day shipping on nearly all of the items Jantzen stocks. These items change every 13 weeks as a new offering of merchandise averaging 200 different styles is brought out. In addition, precise usage of all Jantzen production plants and close coordination with contractors will yield substantial savings in the pivotal labor and material areas. These advantages, plus better decision-making in market estimating and forecasting, embody the greatest initial advances of the system.

• Finance—budget goals and financial results are compared by monthly statements, prepared on the computer. Expenses are automatically allocated to the many company divisions and factory operations.

The computer order allocation system so necessary to the marketing arm of the business provides a periodic inventory-turn analysis for finance.

Analysis of material usage variances in production is possible through the factory programs.

The normal accounting functions of accounts receivable, accounts payable, invoicing, and payroll preparation are completely controlled by the computer system.

The Jantzen 1410 has 60,000 characters of storage, four 729 magnetic tape units, a random access 1301 disk storage unit capable of storing 28 million letters or numbers, one 1403 1100-line-per-minute printer, two high-speed card

sorters, one 088 collator, a 557 interpreter for card verification and punch-to-print, and a 1013 card transmission terminal which sends data at the rate of 96 cards-per-minute to another 1013 at Seneca, South Carolina.

The Seneca device is linked to a 1401 computer which then produces cards, invoices, and other documents as needed. The Seneca installation also transmits reports, invoice information, and other data back to Portland.

A card tabulating installation at Vancouver, Washington, is now used for some shipping and billing operations, but will be replaced in October, 1965, by a prebilling arrangement in which the invoice is included in the shipping carton.

All mass files will be on disk or tape in the 1410 installation by the end of 1965. The account file includes name and address, at least 1 year of sales history, credit data, and other information.

Present daytime operations are largely general accounting, program testing, and research functions. Each week night, at about 6 p.m., a production updating run starts the processing of that day's activity. Order editing, the next run, verifies each order. Next the housekeeping and assignment run is made, based on a nightly sheet of priorities, basic inventory information, and other data as completed for each line by an Order Allocation Controller. All accounts are organized into seven categories for this purpose. Finally the order allocation run, which actually prepares shipping cards and print-out sheets, is made. These nightly runs take about 8 hours.

Basic differences in operation of the System/360, as presently seen, will be elimination of all card file operations by storing this data on tape or in 2311 disk storage drives which have 36 million random-access digit capacity. Additional files will include a 3-year sales history and other data. Three remote inquiry units will permit interrupt and reply via cathode ray display screen or voice. A high-speed printer and a 2321 data cell drive, capable of holding or storing 800 million digits, are also on order.

Basic system objectives are:

1. Accurate daily inventory control—an essential to Jantzen operations which include the largest and most complex garment lines made by any U.S. firm.

2. Order allocation—to provide faster and more precise customer service in which more of a total order can be shipped at one time, without substitutions, and with better assurance of salable quantities in correlated multi-unit lines.

3. Production control—scheduling and dispatching for better utilization of three major Jantzen production facilities plus contractors. This is aimed at more output of better quality with less material waste.

4. Faster, more accurate communication through the Portland-Seneca remote units, generation of more essential data by the 1410/System/360, and more accurate communication with field personnel.

5. Creation of a usable body of facts on apparel merchandising, estimating, and forecasting, large enough for decision making and preparation of meaningful market studies and predictions.

Attainment of these immediate objectives will reveal further profitable applications in moving towards Jantzen's ultimate ideals in this field:

1. Management by exception—computer-generated reports, in essential quantities only, provide enough factual data for decision making. Attainment of this goal is expected to make Jantzen's system pay off at the highest possible level.

2. Decisions so made will create better market knowledge and operations. It should lead to more sales with less inventory at less sales and product cost, with the same numbers of personnel, capital facilities, and materials investment.

DeKoning emphasized that Jantzen would move as fast as possible toward a complete management-by-exception system but will "make haste slowly."

"We'll review our programs to make sure we're turning out only the information we really need while using our imagination to find new ways to use the computer profitably."

DeKoning concluded by highlighting the total management information concept as central to Jantzen's plans. The firm's basic conservatism and sound fiscal position, combined with its realization that progress is essential and that their computer installations are profit-making systems supplying a competitive edge, give Jantzen an excellent chance to achieve the 70-percent expansion it wants in the next 5 years.

Ship Automation

Litton Industries
Beverly Hills, California

INTRODUCTION

A new era for the merchant marine was opened here in August 1964 when the first automated ship built in the United States was introduced.

Called the S. S. MORMACARGO, the 550-foot ship was built for Moore-McCormack Lines, Inc., New York City, by the Ingalls Shipbuilding, Division of Litton Industries, Pascagoula. The $10 million ship is scheduled to carry cargo and passengers between New York and Scandinavian ports.

For the first time in the history of the United States merchant marine the ship's speed can be controlled directly from the bridge. The main engines and boilers automatically respond to movement of a single throttle lever on the bridge, making it possible for the ship to go from zero to full speed in about 5 minutes.

As a safety factor, the engineroom can override the bridge at any time, but the bridge cannot override the engineroom.

Direct contact from the bridge is safer than the former method by which instructions were called to an engineroom crew, which then adjusted the proper valves. The new technique also makes the ship more responsive and maneuverable.

A centralized control console greatly reduces engineers' walking distance an estimated 85 percent. More than 150 operations are now performed by the push of a button instead of manually.

In addition, 108 separate points in the engineroom are automatically scanned every 5 minutes for temperature, pressure, liquid levels, or for motor failures, and the results are automatically recorded. In the event of a dangerous condition an alarm sounds immediately, and the console displays to the engineer the source of the alarm condition. Formerly a fireman was required to monitor gauges throughout the two levels of the engineroom. It took him about 1/2 hour to make a complete trip.

A "bell logger" automatically records information on engine RPM, throttle position, whether the bridge or engineroom has control, time every 1/2 minute, and date. Formerly it was the full-time duty of a man to write this data in compliance with maritime laws.

An infra-red scanner measures the intensity of the flame in the engine burners, and automatically takes correct action if required.

New equipment has also been introduced to the deck of the ship. A constant tension winch enables two men to moor a ship instead of six. A new type "Stulcken" boom and automatic hatch covers greatly reduce the time a ship remains in port for loading and unloading.

Temperatures in the 40,000-cubic-foot reefer in the ship are monitored by remote sensors at 28 points and are recorded on the engineroom console.

The Mormacargo is the first of six Constellation class ships to be constructed by Ingalls. The fifth, the Mormacaltair, was launched by Ingalls today prior to the Mormacargo's demonstration. These ships, with speeds of 24 knots, will be the fastest ships in the maritime service. The Mormacargo was launched on Jan. 25, 1964, and was delivered Aug. 14.

MORMACARGO CHARACTERISTICS

Owner:	Moore-McCormack Lines, Inc.
Builder:	Ingalls Shipbuilding Corporation, a Division of Litton Industries, Pascagoula, Mississippi
Design type:	C4-S-60a
Cost:	In excess of $10 million
Size:	Length (overall) - 550 feet 9 inches Beam (Molded) - 75 feet Deadweight - 12,100 tons max. draft - 31 feet 7 inches Light Ship Weight - 7,700 tons Displacement Weight - 19,800 tons
Propulsion:	Geared Turbine Single Propeller
Speed:	The horsepower and the very fine lines permit an operating speed in excess of 24 knots.

Passengers:	12
Crew:	32
Decks:	7
Holds:	6
Dry cargo:	665,300 cubic bale
Reefer:	Over 40,000 cubic feet
Navigational aids:	Modern Radar Loran Depth Sounder Gyro Compass Radio Telephone (VHF)
Electronic controls:	Engineroom and Bridge Consoles. Throttle can be operated directly from Bridge. Main engines and boilers automatically adjust for change in throttle setting. Electronic monitoring of all main, auxiliary and reefer temperatures.
Keel laid:	April 22, 1963
Launched:	January 25, 1964
Delivered:	August 14, 1964

TECHNICAL DESCRIPTION OF AUTOMATION AND CENTRALIZED CONTROLS

The following discussion of the remote throttle control and "semiautomation" features of the MORMACARGO is confined to the general arrangement and operation of the major components. Detailed description of the various interconnections and controls, which contribute to the smooth overall working of the system, has been omitted.

Throttle Control

The AHEAD and ASTERN throttle valve hydraulic actuators are motor operated and the position of the valves is controlled in response to commands from the throttle levers at the Engineroom Console or the Bridge Console. The actual position of the steam valves and the speed of the propeller shaft are fed back into the control system to maintain the selected rpm. The shaft speed feed back is accomplished by use of two analog tachometer generators driven off of the shaft ring gear which is installed to drive the normally installed shaft tachometer for the Engineroom and Bridge rpm indicators. An additional digital tachometer is also installed to provide a zero speed signal for the shaft-stopped alarm.

When the throttle lever is moved rapidly from AHEAD to ASTERN or from ASTERN to AHEAD positions, the operation of the AHEAD and ASTERN valves overlap. The closed valve begins to open when the throttle lever has passed through the STOP position and the closing valve has moved half-way to the CLOSED position. This position is adjustable over a wide range. The speed of travel of the throttle valves is adjustable and not contingent on the speed of the throttle lever. The speed of travel from CLOSED to full OPEN or vice versa for the throttle valves is adjustable with a range of 10 to 30 seconds. An astern speed limiting device is also included in the hydraulic circuit of the astern steam valve bar lift mechanism.

The throttle valves have modulating characteristics so that the throttle valve opens sufficiently to bring the turbine to the desired speed within the prescribed time limit and then close in to maintain the desired rpm.

The position control of the throttle valves is also dependent on having normal pressure in the steam headers. A pressure transmitter on the line from the superheater headers to the combustion control master steam pressure regulator feeds an electrical signal to the throttle control system. If the pressure falls below a preselected level, the system overrides the valve position reference and controls the valves to maintain the minimum set pressure. If the pressure keeps falling the valves will close all the way. When steam pressure builds back up to normal, the override signal drops out and the steam valves are returned to their previous position.

The position control of the throttle valves is also dependent on having normal water level in the boiler drums. A high water signal is taken from the remote water level indicators for each boiler and fed into the throttle control system. When either level rises to the high level alarm point on the indicators the system overrides the valve position reference and prevents the valve from opening further. Unlike the steam pressure override, the valves are only prevented from further opening and do not close in unless a signal is received from the throttle lever to do so. When the water level returns to normal the override signal drops out.

A manual switch is provided on the Engineroom Console to permit the engineer on watch

to override the water level and steam pressure limits just described. This switch is only operable while the engineroom has throttle control. An indicating light is provided to show when the throttle control limit override switch is being used.

A two-position control mode switch is located on the Engineroom Console. During normal steady steaming conditions at speeds sufficient to use the scoop injection on the main condenser, this switch is in the NORMAL position. Usually in advance of maneuvering or speed reduction, this switch will be turned to the MANEUVERING position. In the MANEUVERING mode the main circulating pump sea suction valve limitorque operator opens the valve, the main circulating pump is started and the astern guard valve limitorque operator opens the guard valve. If the throttle lever is moved to reduce speed below that considered necessary for scoop operation while this switch is in the NORMAL position, the above described operation of sea valve opening, circulating pump starting and astern guard valve opening are initiated automatically. The switch should then be turned to the MANEUVERING mode position to reset the circuit.

OPEN and CLOSE pushbuttons and position indicating lights are provided on the Engineroom Console for the astern guard valve.

The throttle control system is interlocked so that it cannot be energized when the turning gear limit switches indicate that the turning gear is engaged. Lights are provided on the Engineroom Console to indicate whether the turning gear is engaged or disengaged.

In the event of throttle control system failure, the throttle valve motors may be operated directly from the Engineroom Console by use of two spring centering switches if power is available for this circuit and the failure was not due to malfunction of the motors. To change over, the control location switch is turned to DIRECT and the DIRECT THROTTLE AHEAD and DIRECT THROTTLE ASTERN switches are used to position the throttle valves. THROTTLE CONTROL FAILED lights are provided at the Engineroom Console and the Bridge Console and an alarm is sounded on the engineer's alarm panel.

In the event no power is available for the DIRECT electrical throttle control just described, mechanical linkage can be connected to the valve actuators manually. The actuator motors are electrically disconnected when the linkage is engaged to prevent the control system from trying to override the mechanical control when power is restored. Handwheels at the Engineroom Console are used to control throttle valve actuators manually through mechanical linkage.

The transfer of throttle control cannot be accomplished in either direction unless the throttle levers are matched in command. Dual throttle position indicating meters are provided on both consoles for this purpose and a light located above the meters will also light when the levers are matched. Matching the throttle levers provides for "bumpless" (no speed variation) transfer. The Engineroom may resume control at anytime without first notifying the Bridge.

While on Bridge control an alarm is also provided to warn the Bridge when the shaft has been stopped for 3 minutes. The digital tachometer previously mentioned in this discussion provides a signal for this alarm. After the shaft has been stopped for 2 minutes a light will come "on" on the Bridge Console, and after the shaft has been stopped 3 minutes an alarm buzzer will sound. This alarm can be silenced only by moving the shaft or by the Engineroom assuming control.

Additional equipment concerned with throttle control and located on the Engineroom Console is as follows:

1. THROTTLE TRIP pushbutton for manually tripping ahead throttle valves.

2. THROTTLE CONTROL MONITOR test switch with AHEAD and ASTERN test positions and OFF position.

3. CONSOLE LIGHT TEST pushbutton. (One also located on Bridge Console.)

4. Although not associated with throttle control, a thermometer is mounted on the console for measuring air temperature inside console.

Boiler Control

The original Type V2M-8 two-drum, top-fired boilers were modified for wide range boiler operation as follows:

The fuel oil system pressure was increased to accommodate new burner sprayer plates to obtain a 14-1 turndown. The fuel oil pressure required at the burner varies from approximately 20 to 280 psig, the lower pressure allowing all six burners to remain lighted at all times

without overfiring. The burners are steam atomizing type and the steam pressure to the burners follows the fuel oil pressure by 5 psig up to a steam pressure of 80 psig. Above a fuel oil pressure of 85 psig, the steam pressure remains steady at 80 psig. The range of each burner under the arrangement just described is from approximately 1770 to 125 pounds of oil per hour.

Due to the wide pressure variations required at the burners, a new valve was installed to regulate the pump discharge pressure and maintain about 75 psig above the pressure required at the burners. The purpose of this is to minimize wear on the fuel oil regulating valves to each boiler across which this pressure drop takes place. The pump pressure regulating valve is actuated by an air signal received from a pneumatic transmitter at the Combustion Control Board.

For steaming at low rates, it was considered that the forced draft fan inlet vanes were not adequate to limit the air to the burners. A control or "discharge" damper was installed in the air supply duct to each boiler and they are controlled by the steam pressure regulating drive motor in the Combustion Control cabinet. The size of the motor was increased to take care of this added function. These dampers are wide open for most of the firing range and come into operation only at the extreme low end to prevent the fires from blowing out.

Although not directly involved in boiler control, a steam dump feature was added in the plant to take care of conditions of temporary overfiring should they ever occur. This was accomplished by the use of an additional controller for the originally installed auxiliary exhaust dump valve to the auxiliary condensers. This additional controller takes a signal from the combined sensing line to the Combustion Control steam pressure regulator (measuring superheater outlet header pressure). It is not that this steam dump will ever come into play, but it is an added feature providing for unexpected or abnormal steaming conditions.

Since it is intended that all burners remain lighted at all times, except for cutting out in port, a flame scanner system was installed to indicate that all burners are functioning properly. The system consists of a solenoid valve in each burner branch line, a three-position switch for each burner, a flame scanner at each burner, and a panel at the boiler gauge board consisting of indicating lights, micro-ammeters, and tripping switches. The lights and micro-ammeters indicate burners are lighted and the condition of the flame. The tripping switches are for cutting out burners remotely at the control station. Flame failure at any burner initiates the shutdown of fuel oil to that burner and is visibly and audibly alarmed at the control station.

The three-position switch at each burner consists of an ON position when the scanner is in use, an OFF position used to close solenoid valve at the burner when securing it, and an EMERGENCY position for operation without the scanner system in use for that burner. When in this last position, a light at the panel at control station indicates that the scanner system is being by-passed. When lighting off, normally the switch should be in the ON position. When the torch is inserted, the scanner "sees" the flame and opens the solenoid valve allowing fuel oil to be supplied to the burner.

The Coast Guard required an additional low water alarm completely independent of the originally installed remote water level indicator with its high- and low-water level alarms. The connections for this additional unit were taken off of the drum nozzles being used for the connections to the feed water regulators. The low level alarm point was set below the original low level alarm and the new alarm point is used to initiate shut down of fuel oil to the boiler involved when this point is reached. The alarm is indicated visually and audibly. The fuel oil shut down is accomplished by individual solenoid valves to each burner. An adjustable time delay prevents shutdown during rolling and pitching.

Temperature Scanner

An electronic remote temperature scanner system of the "resistance-temperature-detector" type was installed to read 84 points throughout the plant. The scanner unit has 12 banks of nine points, each allowing temperature points in the same range to be grouped together. Each bank has a separate alarm set point to indicate an abnormally high temperature.

There are two types of installations at the locations being monitored. One is the tip sensitive RTD probe that is installed in an existing or new thermometer well. The other is the pad type RTD, also tip sensitive, which is attached to its location by a holder designed for that service. The pad type unit reads surface temperatures such as motor and line shaft bearing temperatures.

The scanner unit and recorder is located at the main control console and is continually

monitoring the points in sequence. The operator may obtain a print out of the readings at any time on a strip chart but this function is on demand and the unit does not print continuously.

A list of the point numbers and their locations is provided as well as a mimic board for identification of the points being monitored.

Lube Oil Temperature Control

To provide for automatic temperature control of the main propulsion turbine and gear lubricating oil, a thermostatic valve was installed to allow the flow of oil to be divided through and around the L. O. coolers. The valve receives its temperature indication from downstream of the coolers and proportions the flow of oil through the cooler and by-pass to obtain the desired temperature.

Shaft Alley Bilge Pump

A shaft alley bilge well sump pump was installed to keep the bilge well in this space from overflowing. The pump is automatically controlled by a float switch but may also be controlled at the main control console. A high level alarm for the shaft alley bilge well is also provided in the event the pump does not start automatically or is not able to keep the level from rising above a certain point.

Main Feed Pump Recirculating

It was determined that for all conditions of PORT and STANDBY operation and for low steaming conditions that it would be necessary to have main feed pump recirculating valve open. A flow of steam to the main turbine was determined at which the recirculating valve could be closed. This flow was related to a pressure in the H. P. turbine first stage and a signal was taken from this point to actuate a control valve in the feed pump recirculating line. The valve is wide open for PORT and STANDBY conditions and does not start to close until the predetermined H. P. first stage pressure is reached. The valve is modulated from this point for about 30 psi above the point when the valve will be fully closed. When wide open, the valve will pass the required quantity of recirculating water to assure proper pump operation.

Turbo-Generator Start Up

To allow a one man start up of the T. G. sets, the normally-installed hand-operated lube oil pump was provided with a motor, speed reducer, and V-belt drive.

Central Operating Station

The foregoing plant modifications were made with the view of providing for bridge throttle control and a one man engineroom watch. To this end the central operating station in the engineroom was arranged as follows.

The location of the station is on the operating level just forward of the boiler firing aisle. In addition to the throttle control console and combustion control board the following items required for central operating control are also located at the station:

- Steam temperature control panels
- Flame scanner panel
- Main and Boiler gauge boards combined
- Soot blower control panels
- Engineers alarm panel
- Watch call bell system
- Meters for indicating condition of electrical plant
- Cargo reefer temperature recorder and indicators
- Cargo reefer recirculating fan pushbuttons
- Sound powered telephones
- Pushbuttons for F. O. Service Pumps and Forced Draft Fans

Several other refinements were also added such as additional gauges and a control air low pressure alarm to provide for closer supersion of the plant.

Computerized Crime Information

Los Angeles Police Department
Los Angeles, California

An advanced scientific technique for natural-language processing of crime information via high-speed computer was announced by the Los Angeles Police Department and System Development Corporation, a non-profit research and development firm.

The LAPD-SDC program represents the first police application of computer processing in natural English language. In effect, this enables the police officer to "talk" with the machine. The technique was judged "highly effective" during an experimental study conducted by the two organizations during the past year.

The crime information experiment, believed to be the first of its kind in the country, was conducted with the approval and support of the Los Angeles Board of Administration. The Board, chaired by the City Administrative Officer, includes representatives from the Mayor's office, the City Council, and other City offices.

Officials said the joint program demonstrated that computer processing of crime reports in original English language form was both possible and desirable, and offered "a real possibility for a major breakthrough" in the law enforcement field.

Deputy Chief of Police Richard Simon pointed out that this type of program holds great promise for the operational law enforcement officer as well as the command staff of the department.

"The modern police department must avail itself of advanced computer techniques if it is to face the steadily growing volume and complexity of information associated with increasing population and corresponding rise in crime," Chief Simon said.

The experiment was conducted with reports of actual robberies committed in the City of Los Angeles during the past year. Information was relayed via ordinary teletype circuits to and from a high-speed computer at SDC's Santa Monica headquarters. This computer is being utilized simultaneously by many different user organizations in a Department of Defense computer time-sharing research project.

Spokesmen for the Los Angeles Police Department and SDC said they are continuing to refine their approach and make improvements in the system. They added that results of their study probably would be incorporated in any operational computer system which might be developed by the Los Angeles Police Department.

Work on the joint LAPD-SDC project was co-directed by Lt. William W. Hermann, officer in charge of the Systems Research and Design Section of LAPD, and Herbert H. Isaacs, Manager of Special Systems Projects, at the System Development Corporation.

SDC, a non-profit corporation, specializes in the design and development of computer-based command control and information systems for military, governmental, scientific, and educational applications. The corporation, which has its headquarters in Santa Monica, Calif., has major facilities in Falls Church, Va.; Lexington, Mass.; Paramus, N. J.; and Colorado Springs, Colo.

L and N IBM 1050 Tele-Processing System

Louisville and Nashville Railroad
Louisville, Kentucky 40201

A passenger coach loaded with electronic hardware is rolling over the rails of the Louisville & Nashville Railroad. The coach, renumbered 1050 to match the IBM 1050 Teleprocessing system it has aboard, has operable machines in a simulated yard office at one end and a division office in the other. Said to be a "first" in railroad circles, the car will be used to accommodate groups of employees for lectures and demonstrations of just how the new 1050 system actually works.

In effect, a classroom on wheels, the car began its tour November 15, 1964 at Louisville with a series of sessions, at which time top division officials were shown how the 1050 system will be used and how the machines actually operate. The special car is scheduled to visit all cities on the L and N where the 1050 field units will be located. At these stops, employees will be given a concentrated course in proper operational procedures before the machines are placed in actual service.

This particular 1050 system will not be sending any data beyond the confines of the coach, but by mid-January 1965 the L and N began field installations, and by the end of this year expects to have them located at 27 yard offices throughout its 13-state territory. In addition, other units will be placed in each of the company's nine division headquarters.

Installation will be done about a month apart, roughly on a divisional basis, starting at several points in Eastern Kentucky, and these units will be activated immediately. When the entire 1050 network is complete, a wide variety

of operational and statistical information will be channeled to Louisville through an IBM 1448 switching center, a 1460 computer, and 1311 disk files until IBM's new, larger and faster System/360 computer is installed in 1966.

Utilization of the 1050 system presents a new challenge, the L and N said. Some immediate uses will include transmission of information to provide instant and completely accurate data on train consists, interchanges, shop car reports, departures and arrivals from local industries, and car accounting. It also will transmit administrative messages such as hold track reports, engine utilization data, centralized reports and statistics. Many other types of reports are envisioned, a number of which are already in the planning stage, and, as the L and N put it, "this places the railroad industry on the threshold of a completely new era."

Computerized Records of Traffic Lights

Department of Traffic
The City of New York
Long Island City, New York 11101

A modern data processing system to handle the operational and maintenance records of the New York City Department of Traffic was installed in December 1964. One of the principal tasks of the new system will be to keep installation, control, and maintenance records for traffic lights at approximately 9,000 signalized intersections and 60,000 parking meters located throughout New York City's five boroughs.

The Department of Traffic, in announcing the new system, reported that this installation would significantly improve their ability to keep accurate track of all equipment as well as provide better control of maintenance. This now becomes increasingly vital as New York City embarks on a $100 million electronic signal modernization program.

Heart of the new data processing system is a UNIVAC 1004 Card Processor, a versatile high speed electronic card processing machine designed and built by the Sperry Rand Corporation's UNIVAC Division.

The new system will provide detailed records of every traffic signal light, pole, controller, detector, parking meter, and other associated equipment on the city's streets. It will also record reports of defective equipment and the time of repair in order that the department will have assurance of prompt repairs by its maintenance contractors.

In addition to providing records relating to signals and meters, the equipment will keep a complete record of traffic accidents in the city. These data will help the department's traffic engineers to pinpoint dangerous and potentially dangerous intersections requiring corrective traffic control measures.

Future applications envisaged by the department include inventory records for its sign and signal shops, motor vehicle records, payroll, time keeping, budget operations, personnel, and accounting operations.

Police Computer System

Metropolitan Police Department
St. Louis, Missouri

The first components of an advanced police computer system were installed in October 1964, with additional items arriving in December.

With the installation of the IBM 7040-7740 computer system, the St. Louis Metropolitan Police Department will have a new and powerful ally in its fight against crime.

This computer system is designed specifically to assist in crime detection and control. Once operative, patrolmen, detectives, and neighboring law agencies will have almost immediate access to vital information stored in the computer's vast memory.

Col. H. Sam Priest, president of the Board of Police Commissioners, pointed out that it will take several months of testing after installation, before the system is fully operational and several years before the full potential of the system will be utilized.

"It should be emphasized that complex equipment like this does not become operational overnight, despite the fact that we have been planning for it, and establishing programs for many months.

"This is another step in a continuing effort to give the department the most modern facilities available.

"Acquisition of the system will make the local police department a world leader in the application of electronic data processing to help fight crime," he stressed. "This is a pioneering effort being watched with a great deal of interest by police agencies throughout the world."

"In the past, using a small punched card system, we have developed methods which have served as models for police departments in the U.S., Japan, Turkey, Indonesia, England, and Canada.

"Now with the speed and adaptability of the new computer system, we will have a major tool to help policemen make St. Louis a more crime free community."

Col. Curtis Brostron, Chief of Police, explained that the primary purpose of the new system is to aid the patrolman in the field.

John Juwer, Director of Data Processing; described one of the great many operations which the computer will perform to assist the officer on the street.

"An officer in a patrol car sees a vehicle he suspects has been stolen, or a man who may be on the wanted list. He calls headquarters on his radio and gives the dispatcher a description of the car, the man, or both and the license number.

This information is punched into the keyboard of the terminal which transmits directly into the computer system. In about 3 seconds the system provides a positive or negative response which is channeled back through the system to the terminal where the reply is immediately printed out for the radio dispatcher. It is then transmitted by radio back to the inquiring officer.

"It's easy to see how much more efficient a patrolman can be," asserted Col. Brostron. "Instead of waiting up to 20 minutes with a suspect to get information, the patrolman can get his answer almost immediately and have the additional time to devote to his job of crime prevention. It's just like adding men to the force," he said.

In addition to the new applications, the computer center would produce crime analysis reports, plus many routine reporting and accounting procedures previously done on the punched card system. Those include arrest record accounting, criminal identification, radio call reporting, excise tax recording, gasoline and personnel accounting, and field activity accounting. Also, the system can prepare, in minutes, comprehensive reports on the types of crime being committed, and where.

Ability to retrieve information of this nature on almost a minute-to-minute basis, has important ramifications in efficient use of their resources. Computer prepared analyses can help assign the 1,850 police officers and 400 vehicles in areas where they are the most needed. To develop a new patrol plan previously took about a year ... now it can be done daily if desired. More effective utilization of manpower and equipment should significantly minimize the scope of criminal activity in St. Louis.

Integral parts of the new system are a 7040, a 7740 message control system, seven 1050 terminals, a 1301 disk file which stores 56 million characters of information including stolen and towed autos, stolen St. Louis area license plates, names and descriptions of wanted persons and missing persons, detailed descriptions of stolen property, and a file of known criminals.

Facilities to house the computer center have recently been completed on the third floor of headquarters building, 12th and Clark, where room for future expansion was planned when the building was constructed in 1927.

Computer-Based Justice Identification and Intelligence System

System Development Corporation
Santa Monica, California

The State of New York and the System Development Corporation have begun work on the development of a computer-based identification and intelligence system for agencies concerned with the administration of justice in New York State.

Announcement of the system was made in New York at a Conference on State and Local Government EDP Systems by R. R. J. Gallati, New York State director of the system.

The new information processing system, utilizing modern computing techniques, is expected to significantly increase the speed and efficiency of information handling over present manual methods. It will be capable of rapidly and efficiently receiving, processing, storing, and retrieving information required by local and state agencies in the course of discharging their duties.

Work on the first phase of the system is under way be SDC scientists and New York State personnel in determining the requirements of the various state and local agencies which will use the new system. When implemented, it will serve New York police departments, sheriffs' offices, district attorneys, the criminal courts, correction departments, and probation and parole agencies.

Eliot Lumbard, Special Assistant Counsel to Governor Rockefeller for Law Enforcement in the State of New York, said the computer-based system offers "a real possibility for a major break-through" in the identification and intelligence field.

"New and larger categories of information as well as files and filing systems have increased with such speed in recent years that their sheer volume alone is drastically reducing the accuracy and timeliness that they were intended to serve. Until recently it looked as if we would become bogged down in a piece-meal approach to the goals of criminal justice," Lumbard said.

"By adopting a system concept, and using electronic information processing, there is a real possibility for a major break-through in efficient, high-speed handling of law enforcement and criminal justice information," he said.

Some of the studies to be undertaken during the initial phase of the project will be the function and role of the various local agencies participating in the system; requirements for equipment and procedures to protect the security of information; study of transmission equipment and lines to be used between the using agencies and a central data processing facility; and an equipment evaluation.

In 1963, SDC prepared for New York State an Information Requirements Analysis which examined and defined the requirements for an identification and intelligence system. Future developmental work on the system will encompass System Production and System Installation.

Work on the system is being performed by scientists from SDC's Paramus, N. J., facility under the direction of Dr. Ezra Geddes.

SDC - Denmark Time-Sharing Demonstration

Systems Development Corporation
Santa Monica, California

A 6000-mile international demonstration of computer time sharing took place between Copenhagen, Denmark and Santa Monica, California on the morning of November 19, 1964 at 9 a.m.

Physicians attending the world health organization's conference on information processing and medicine in the Danish capitol communicated directly with a high-speed computer in laboratories of the System Development Corporation (SDC) in Santa Monica. Transmission was made via Western Union Telex.

This 6000-mile span is believed to be the longest distance over which information has ever been transmitted between a remote input station and a central computer in a time sharing operation.

Danish sponsors to the demonstration included the I/S DATACENTRALEN, The Copenhagen County Hospital Association, The Danish National Health Service, The Copenhagen Police Department, The Danish Hospital Association, The Danish EDB (Information Processing) Association, and the Danish Management Association.

The purpose of the demonstration was to acquaint European physicians with the significant advances in data processing which now allow them to communicate directly with a computer. Previously, most medical computer uses have been restricted to a more involved system where doctors described their problems to computer programmers, who then translated them into computer understandable terms which were fed into the computer. The results sometimes

took hours or days before receipt. SDC time sharing system, on the other hand, permits near instantaneous communication between user and computer.

Western Union International, whose facilities provided the transatlantic communication link, monitored the line during the transmission to ensure highest reliability and quality of service.

Direct access to the SDC computer from the Western Union Telex system was made possible by equipping two standard Western Union Telex sets with special interfaces, or signal translators, which translate regular Western Union Telex signals into a signal that the computer can read. Once a connection is established, a written conversation then takes place between the remote caller and the SDC computer.

The signal translator interfaces were specially engineered and provided by the Weste n Union Telegraph Company for this demonstration as part of the company's developmental program in the total tele-communications field.

The computer time-sharing program which has been in operation 8 hours a day at System Development Corporation since January 1963 is being expanded to handle a maximum of 30 or more customer programs simultaneously. Approximately 100 customers use the system at different times.

The SDC developmental work may lead to a nation-wide operating network which would enable many thousands of people to share, virtually simultaneously, the power of a large, centrally located computer at reasonable costs.

This multiple use of a computer, or time sharing, has been the subject of a major research and development program at System Development Corporation since early 1963, under the sponsorship of the Advance Research Projects Agency of the Department of Defense.

Included in the demonstration were the following programs:

ECCO—This program demonstrates a personnel data retrieval system which provided on-line inquiry capability for searching personnel data files, makes statistical computations on the data, and prints out the required information.

VALE—The Veterans Administration Laboratory Experiment Program was designed to explore input techniques for laboratory data, to determine the flow of information between the laboratory and wards accurately, to develop coding techniques for medical data, and to establish an effective format for displaying the data that has been collected.

TINT—TINT is a tool used within the time-sharing system that enables the programmer to perform on-line programming functions via teletype machines.

SYSTHEX—This program demonstrates how the computer accepts simple natural language questions about material in the "Golden Book Encylopedia" and how the computer responds to the questions with simple natural language answers.

Optical Scanning of Airline Tickets

United Air Lines
Chicago, Illinois 60666

High speed optical scanning equipment, capable of reading airline tickets at the rate of 600 per minute and automatically transferring accounting information to computers, was purchased by United Air Lines in September 1964.

Called an Electronic Retina Character Reader, the equipment will speed direct processing and auditing of United's flight tickets and auditor's coupons. The new system eliminates manual key punching of data in ticket accounting operations. It is expected to reduce processing time and cost dramatically.

It is the first scanner capable of transporting and sorting paper as light as 9-pound stock or carbon backed paper such as that used for airline tickets.

Information including such items as the routing, fare, tax, totals, carrier code, and fare basis are correlated with a route code, read from the ticket, and transferred to magnetic tape by the new machine.

The device also performs various sorting operations including sequential sorting of tickets or air bills by number, carrier or both. The machine sorts as rapidly as it reads.

Manufactured by Recognition Equipment Incorporated of Dallas, Texas, the equipment

has been installed at United's headquarters offices near O'Hare International Airport, Chicago.

The reader recognizes preprinted or matrix-applied numerals through an optical system and an Electronic Retina as each numeral or figure passes in front of the retina, which is a battery of hundreds of light sensors that read each character in all of the various shadings it is printed in. Scanning time per character is measured in millionths of a second. The optical recognition technique employed in the device resulted from a study of the seeing characteristics of the human eye.

United records and audits in excess of one million airline tickets a month on electronic computer equipment, and currently the basic data is transferred to magnetic tape by use of key-punched cards.

New United tickets now employ a precoded ticket number positioned to be read by the scanner along with numeric routing data added at the time the ticket is sold. Readable impressions include originals and carbons made by plastic route matrixes and air travel cards.

The new equipment includes three basic units consisting of a document carrier, a recognition unit, a programmed controller and a magnetic tape drive. The unit is comparable in size to existing computers.

The control unit, in addition to programming the system and recording data read by the scanner, can be used as an off-line scientific computer. It can read from or record data on magnetic tape, punched-paper tape, or a typewriter.

The highly versatile scanner will negotiate various papers down to 9-pound stock, as well as carbon-backed papers such as that used for airline tickets. Although intended to process documents prepared and handled with reasonable care, the transport system permits the unit to process and read papers which have been torn, crumpled, or stapled.

Through use of a check digit technique programmed into the machine, United expects to reduce the machine's substitution rate to almost zero. Overall rejection rate for preprinted flight coupons will not exceed 2 percent, according to the manufacturer.

Although the United equipment will utilize only the numeric reading capabilities of the Electronic Retina Character Reader, the machine can be modified or expanded to incorporate at least six alpha-numeric fonts for more diversified operation.